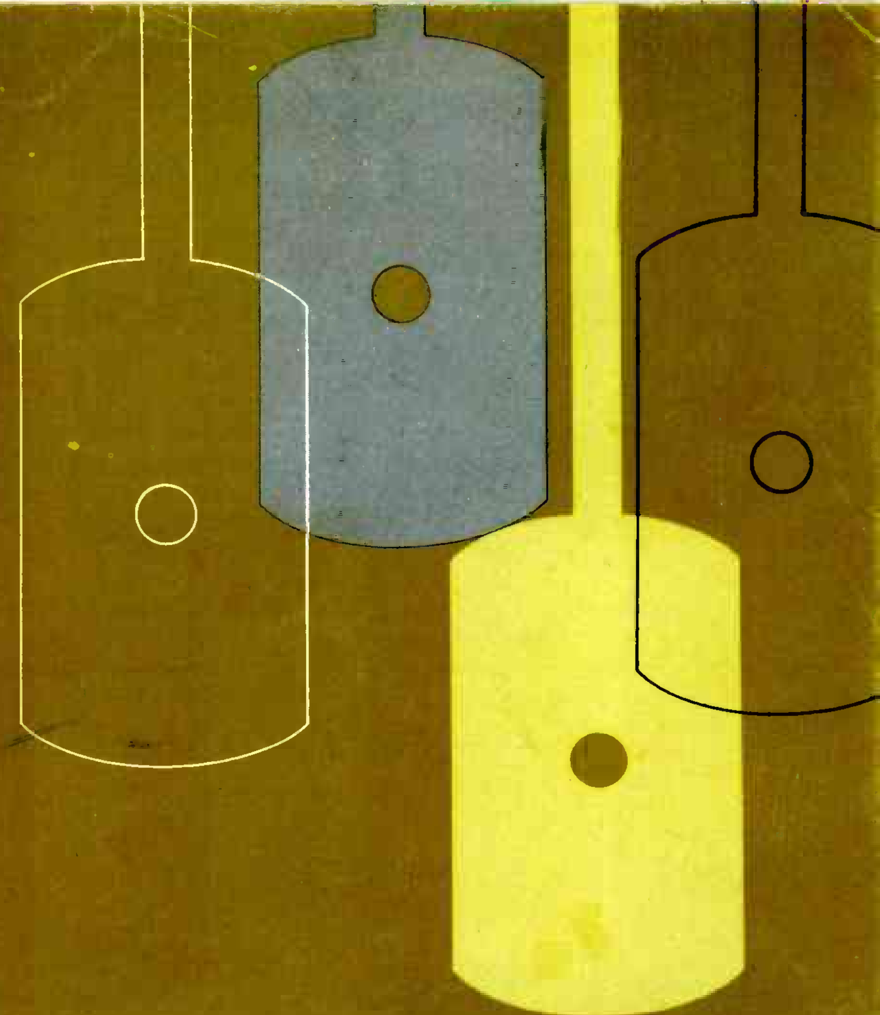
PC BOARDS



- Programmable Scanner
- Repairing PC Boards

nri journal

Autumn 1978

www.americanradiohistory.com

Instruments for the Eighties.

New from CONAR.

Three of the most popular and useful basic test instruments
ever offered by CONAR, now completely redesigned
with state-of-the-art technology.
The Model 312 Resistance/Capacitance Decade,
the Model 281 Signal Generator, and the
Model 231 Signal Tracer.
Improved solid-state circuitry. New styling. More compact size.
Digital readout in the 312 and 281.
Complete specifications and prices are given in this issue of the Journal.
Presently available only in kit form. Wired units will be available
early in 1979.
Order now from CONAR.

Model 231 Signal Tracer

Stock No.231UK

A superb instrument at a price you can afford. And it's backed by the CONAR guarantee—"the best in the industry."

Student Price

Only $58.50

Plus shipping and insurance
(Check the CONAR catalog for Parcel Post and UPS rates)

KITS ONLY
until early 1979

Specifications

Probe: High input impedance FET connected in a source follower circuit. **Input Modes:** A selectable ceramic filter. Tuned inputs covering the standard broadcast i-f frequencies (262 kHz, 455 kHz, and 10.7 MHz, untuned rf and audio. **Semiconductors:** Three integrated circuits, three transistors, and five diodes. **Controls:** volume, band switch, coarse attenuator switch, fine attenuator/on/off switch, am/fm switch. **Power Requirements:** 110-120 volts ac, 60 Hz. **Dimensions:** 8½" wide by 6" high by 6½" deep. **Shipping Weight:** 6 pounds (13.2 kg).

www.americanradiohistory.com

nri journal

Autumn 1978
Volume 36, No.5

Editor and Publisher
William F. Dunn

Technical Editor
Ted Beach

Managing Editor
Tom Beadling

Associate Editor
Audrey Schreibstein

Feature Editor
Max Cohen

Art
William Johnson

In this issue, Journal editor/publisher Bill Dunn surveys one of the hot new applications of microcomputer technology, the programmable scanning receiver. And, certainly not to be outdone, NRI student/author Steven L. Williams tells us how to handle repairs on those delicate PC boards with precision, finesse, and savoir faire.

The NRI Journal is published quarterly by the National Radio Institute, a division of the McGraw-Hill Continuing Education Center, 3939 Wisconsin Avenue, Washington, D.C. 20016. The subscription price is two dollars yearly or 50 cents per single copy. Second-class postage is paid at Washington, D.C.

www.americanradiohistory.com

A Microprocessor Controlled Programmable Scanning Receiver

Ever since fire and police departments began using radio communications, it has been a popular pastime to monitor these broadcasts. The first fire and police radios operated in a band just above the high-frequency end of the standard am broadcast band. Often you could hear some of these stations on an ordinary broadcast receiver. When the fire and police departments moved to the vhf and uhf bands and the use of radio for all types of communications increased, it became impractical to try to tune all these different services with a continuous tuning receiver. Then, with the advent of transistors and integrated circuits, scanners came on the market that could scan a number of preselected channels and automatically stop on any channel on which a signal was picked up and remain there until the end of the transmission.

The trouble with the first scanners was that the oscillator was crystal-controlled and a separate crystal was needed for each channel. If you bought enough crystals to cover most of the available activities in any area, you could easily end up with as much money invested in crystals as in the original scanner.

Radio Shack® recently introduced a programmable fm scanning receiver Model PRO-2001 (manufactured by Realistic®, a division of the Tandy Corporation) which eliminates the need for all these crystals. This model will scan 16 channels plus a monitor channel in any combination in the vhf-low band (30 to 50 MHz), the vhf-high band (144 to 174 MHz), and the uhf band (430 to 512 MHz). The receiver uses two CMOS RAMs (random access memories), one microprocessor IC, 29 integrated circuits, 40 transistors, 69 diodes, a seven-digit LED frequency display, and 17 LEDs (light-emitting diodes). The receiver, which is a superheterodyne, operates on 120 volts, 60 Hz or 12 to 15 volts dc. It includes a digital synthesizer which can be programmed on 16,560 different frequencies. A photograph of the PRO-2001 programmable scanner is shown in Fig.1.

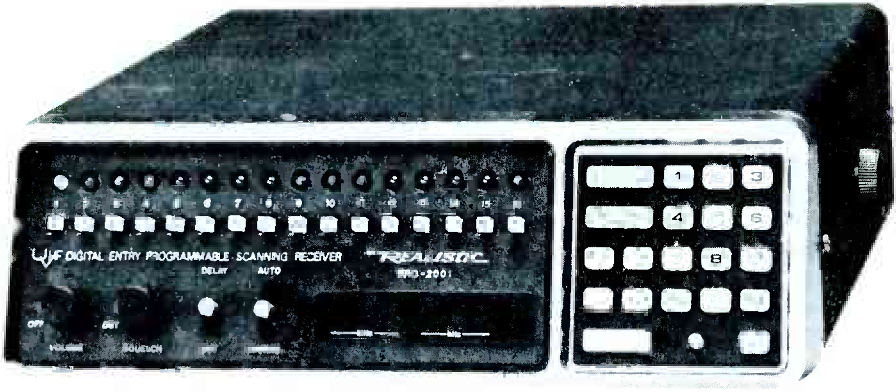
For a receiver that has such capability, the scanner is relatively easy to operate. The first thing you have to do is remove the battery compartment cover and install a nine-volt battery. This battery is needed because the scanner contains an electronic memory. Without the battery, the channels you have programmed into it would be lost when the power was turned off.

Once you have the nine-volt battery in the battery compartment, you connect the uhf and vhf antennas to the antenna jacks, plug the receiver in, and you are ready to start.

Let's suppose that the local fire department is operating on a frequency of 154.140 MHz and you want to enter this frequency on Channel 1. To do this, turn the equipment on by rotating the VOLUME control (which can be seen at the lower left in Fig.2) about one-quarter turn. Press the SCANNER key on the right and then press in all the channel switches. Rotate the SQUELCH control fully counter-

Bill Dunn

www.americanradiohistory.com



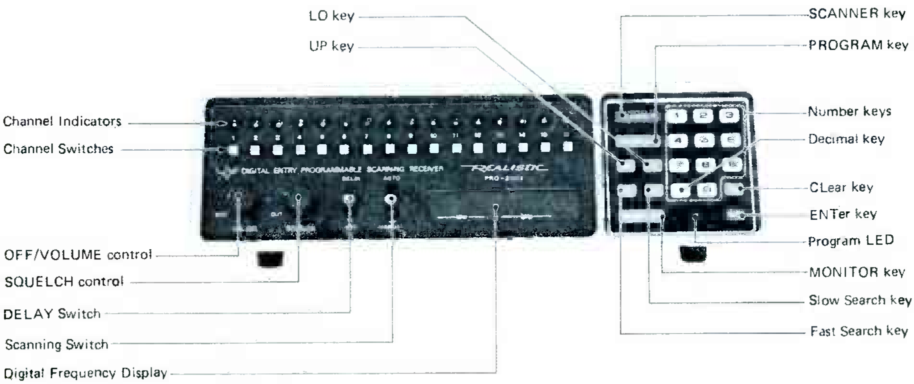
Courtesy Radio Shack

FIGURE 1. A REALISTIC PRO-2001 PROGRAMMABLE SCANNING RECEIVER.

clockwise. You should hear a rushing sound from the speaker. Now adjust the SQUELCH control clockwise until you no longer hear the rushing background noise.

In approximately the center of the receiver under Channel 8 is the scanning switch marked AUTO on top and MANUAL on the bottom. When this switch is in the AUTO position, the receiver will scan automatically. When the switch is in the MANUAL position, you have to keep moving it down to move one channel at a time.

Manually operate the scanning to get the receiver to Channel 1. When you have it on Channel 1, the Channel 1 indicator LED will light. Now press the PROGRAM key. The PROGRAM LED will light up. Next use the calculator-type keyboard to enter the frequency 154.140. Press the ENTER key on the lower right of the receiver and the frequency is now stored in Channel 1,



Courtesy Radio Shack

FIGURE 2. THE PANEL LAYOUT.

www.americanradiohistory.com

and will be displayed by the seven-digit digital frequency display.

You can now use the scanning switch to move the receiver to Channel 2 and store a different frequency in this channel. The frequency need not be in the vhf-high band. It can be in this band or it can be in the 30 to 50 MHz or 430 to 512 MHz band.

One channel that you'll probably want to set up is the National Weather Service. Different frequencies are used in different parts of the country, but you should find the Weather Service on either 162.400 MHz, 162.475 MHz, or 162.550 MHz.

Now that you have Channel 1 set at 154.140 MHz, move the receiver manually by means of the scanning switch to Channel 2. Once again press the PROGRAM button and the PROGRAM LED will light up. Enter the frequency 162.400 and then press the MONITOR button on the right of the scanner. If you hear the Weather Service, press the ENTER button and the frequency will be stored in Channel 2.

If you do not hear the Weather Service, press the CLEAR button and this will wipe out 162.400 MHz. Now enter 162.475 MHz and once again press the MONITOR button. If you hear the station, press the ENTER button and this frequency will be stored in Channel 2; if you do not hear it, once again press the CLEAR button and then enter 162.550 MHz. You should hear the Weather Service on one of these frequencies.

NORMAL SCANNING

If you know the frequencies of the various services in your locality which you wish to monitor, you can move the receiver to Channel 3 and then to 4 and so on, setting up one of the frequencies on each channel. Once you have 16 frequencies stored in the receiver, switch the scanning switch to AUTO, and press the SCANNER key; the receiver will begin scanning the various channels automatically. Push the DELAY switch up when the receiver stops on a channel. Since there is a signal present, it will not go on to the next channel until two seconds after the transmission is ended. Therefore, if two stations are transmitting on the same frequency and one is replying to the other, you won't miss the reply because the scanner has moved on.

With the National Weather Service programmed into Channel 2, you will find that your scanner scans through and then stops on Channel 2 and stays there. This is because the weather broadcast is continuous. Once you've heard all you want to hear about the weather, press the Channel 2 button in and then allow it to pop out. The scanner will then proceed to scan the other channels and will skip Channel 2 as it goes by.

FINDING A STATION

Earlier we explained how to set up the local fire station operating on 154.140 MHz and Channel 1. However, suppose you do not know the frequency on which the fire station operates, but you still want to set it up on Channel 1. You can use the search function to find the station. Fire stations operating in the vhf-high band operate in the frequency band 154.130 to 154.445 MHz. The scanner will scan this frequency band for you and find the station.

Press the SCANNER key to select Channel 1. Set the squelch control to a point where the annoying background noise just stops. Press the PROGRAM key. The PROGRAM LED will come on. Press the LO key and then punch the numbers for the lower frequency

www.americanradiohistory.com

limit, which in this case will be 154.130 MHz.

Now push the UP key and punch the numbers for the upper frequency limit, which in this case is 154.445 MHz. Press the FS (fast search) or SS (slow search) key to start the search. You can change the searching speed any time by pressing either the FS or SS key. When the scanning monitor finds a station, press the MONITOR button. This halts the search and stores the frequency of the station in the MONITOR memory and lets you listen for a while.

If this indeed is the fire station, you can enter this frequency into Channel 1, or any other channel that you have selected, by pressing the ENTER button.

If you find that the station you have on the monitor is not the station you are looking for, you can resume the search where you left off by pressing the FS or SS key. When you find a second station, once again press the MONITOR. This new frequency will now replace the contents of the monitor memory, and if it is the correct station it can be stored permanently into the channel you have selected for it.

You might at first hear no stations at all as you search the selected frequencies. That's all right. When the search reaches the upper frequency limit (154.445 MHz, in this example), it will automatically start searching again at the lower frequency limit. The search operation will continue until you change the operating mode.

HOW IT WORKS

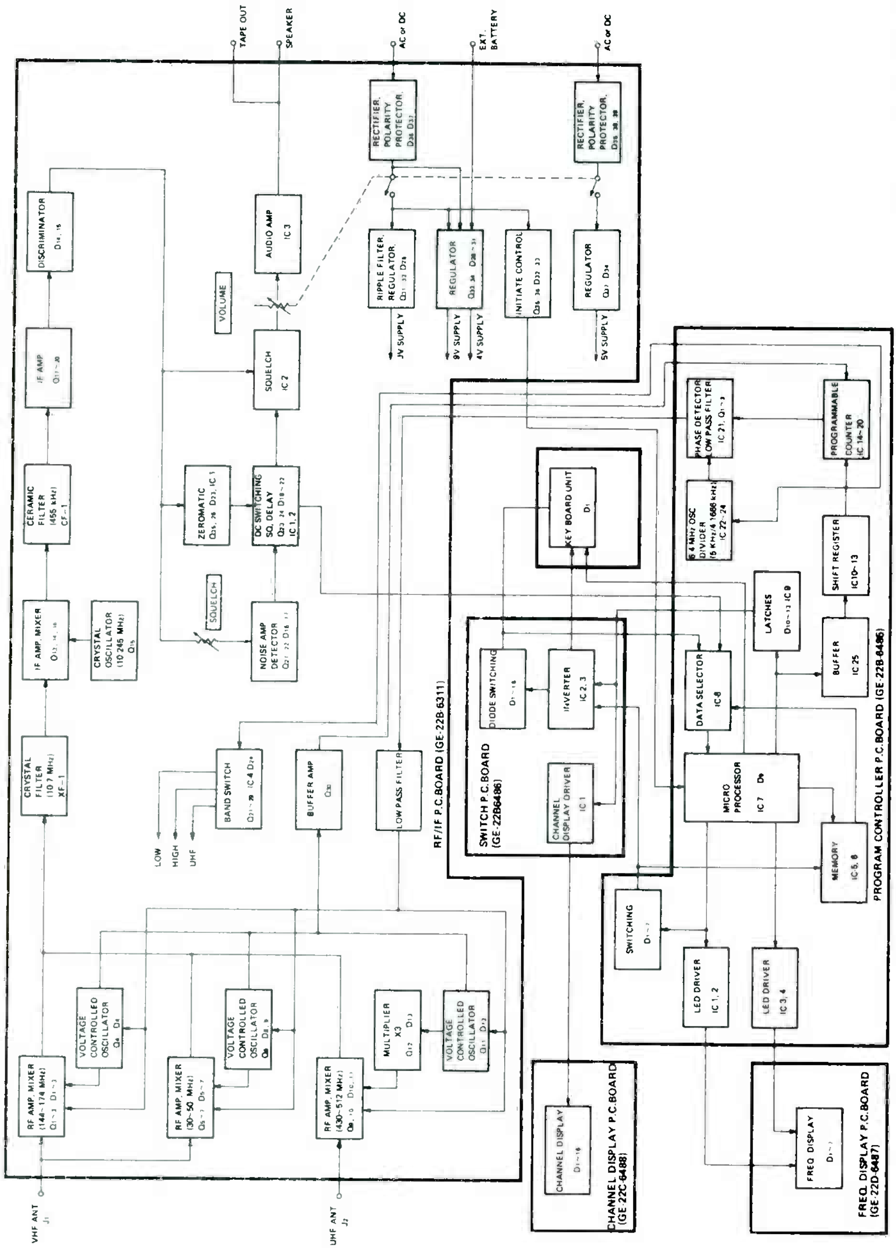
The heart of this scanner is a microprocessor which is receiving signals from a number of sources and sending out control signals in other directions. A microprocessor is frequently referred to as a "computer on a chip." By this we mean that practically an entire computer is contained within a single integrated circuit. The microprocessor is just starting to come into its own. It is going to create an unbelievable growth in the field of electronics.

Figure 3 is a simplified block diagram of the scanner. Notice that there are three rf amplifier, mixer, and oscillator sections, one for each of the vhf bands and one for the uhf band. A signal from the shift register actuates the band switch which determines which band is selected. The oscillator section uses a voltage-controlled oscillator. This is simply an oscillator that uses a varactor diode across the frequency-determining circuits. The voltage applied to the varactor determines the capacity of the varactor and hence the frequency at which the oscillator operates.

In addition to feeding a signal from the oscillator to the mixer, a signal is also fed through the buffer amplifier back to the programmable counter. On the vhf bands, the counter divides the signal to produce a 5-kHz output signal. For example, when the receiver is tuned to 154.140 MHz, one of the channels we set up earlier, the oscillator will be operating 10.7 MHz higher or at 164.840 MHz.

The divider divides this signal by 32,968 to produce a 5-kHz signal in the output. Meanwhile, the 6.4-MHz oscillator also has a divider in the circuitry that divides the 6.4-MHz signal by 1280 to produce a 5-kHz signal. These two 5-kHz signals are fed to the phase detector where their frequency and phase are compared; if the signal from the programmable counter is not exactly in phase with the signal from the oscillator, a correction voltage is developed that is fed through the low-pass filter to the oscillator to bring the oscillator to the correct frequency. You might wonder how the programmable counter knows that it should divide the

www.americanradiohistory.com



Courtesy Radio Shack

FIGURE 3. A BLOCK DIAGRAM OF THE PRO-2001

www.americanradiohistory.com

oscillator signal by 32,968. The answer is that it is given this information by the microprocessor.

On the uhf band, the stations are spaced 12.5 kHz apart. To provide the internal signal needed to convert the incoming signal to a 10.7-MHz i-f signal, the local oscillator generates a signal that is fed through a tripler to the mixer. The signal from the oscillator is also fed to the programmable counter. In shifting from one uhf channel to the next, the oscillator frequency shifts 12.5 kHz ÷ 3 = 4.1666 kHz.

When the receiver is tuned to a uhf channel, for example 467.7375 MHz, the signal from the tripler will be 10.7 MHz above this frequency or 478.4375 MHz. The oscillator operates at one-third this frequency or 159.479 MHz. This signal is divided by 38,275 to produce a 4.1666-kHz signal.

Meanwhile, the signal from the 6.4-MHz oscillator is divided by 1536 to produce a 4.1666-kHz signal. The two signals are compared in the phase detector and if the oscillator is off-frequency, a correction voltage is developed and fed through the low-pass filter to the oscillator.

When you switch to the next uhf channel, which is 12.5 kHz higher, the oscillator shifts to 159.483 MHz. This is tripled to 478.45 MHz by the tripler and fed to the mixer. At the same time, the oscillator signal is divided by 38,276 by the programmable counter to produce the 4.1666-kHz signal. This signal is fed to the phase detector to be compared with the 4.1666-kHz signal from the 6.4-MHz oscillator and divider.

The signal at the output of the mixer is a 10.7-MHz signal. It is fed through a crystal filter to an i-f amplifier and a second mixer where it is converted to a 455-kHz signal. The signal is amplified further and fed to a discriminator and then through the audio amplifier to the output. Notice that the audio amplifier is controlled by the squelch circuit. When no signal is being received, the amplifier is blanked so you don't have to put up with the annoying background hiss that would be present otherwise.

In addition to the signal used to control the oscillator frequency, the microprocessor sends signals to the memory that stores each channel frequency set up. The microprocessor feeds a signal to the LED driver, which drives the frequency display, and feeds another signal through the latches to the channel display driver, which in turn generates the signal that will cause an LED to indicate the channel is tuned.

Notice that the divider used with the 6.4-MHz oscillator divides down to 5 kHz or 4.1666 kHz. On the vhf bands, it divides to 5 kHz, since the various channels in the vhf band are spaced 5 kHz apart. On the uhf band, the channels are spaced 12.5 kHz apart so the divider divides by 4.1666 kHz. Three times this is 12.5 kHz.

The signal is divided to this frequency so that the same low-pass filter can be used on vhf and uhf, and because the oscillator is actually changed only 4.1666 kHz to change the signal fed to the mixer 12.5 kHz. If the divider divided to 12.5 kHz, separate low-pass filters would be required.

All told, the scanner is very well designed. It is an indication of the things to come as microprocessors are more fully exploited in consumer electronics.

The microprocessor is not some fantastic electronic device that is going to come into use some time in the future. It is here now. It is being used in automobiles to control the fuel-air mixture, to control the timing, to tell you how many miles you are getting per gallon of gasoline, and to tell you how far you can go on the gasoline in the tank. It is being used in the home in

www.americanradiohistory.com

microwave ovens and home computers. It is being used in television receivers so that the receiver can be programmed in advance to record the various programs the viewer wishes to see. It will soon be found in practically every kind of electronic device that can be imagined.

Early in 1979, NRI will offer a new course in microprocessors and microcomputers. At the present time, we have prototypes of the microcomputer operating, and it is undergoing quality control tests both to ensure its reliability and to develop additional programming. We will have an innovative, highly original effective method for you to learn all about microcomputers. If you are interested in this new and exciting program, let me know and I'll send you information as soon as it is available.

William F. Dunn

William F. Dunn
Director of Education

When a tree burns, here's what goes up in smoke.

IRS
ATS·B
PPLE CRA
ARD·NOTEBO
P·GLUE·SKIS·BR
E CASINGS·TENNIS R
GLASS·PHARMACEUTIC
ES·WINDOW FRAMES·PLA
·NEWSPAPER·TISSUE PAPER·
ORKBENCHES·LINOLEUM FILLERS
LE DIAPERS·SCREW DRIVERS·RAILR
S·BOBBINS·MANDOLINES·CEILINGS·BAS
RTS·FLOOR
GIES·ACIDS

Now just imagine what happens when a whole forest burns.

Ad Council
A Public Service of This Magazine
& The Advertising Council

www.americanradiohistory.com

Repairing Those (Fragile!) Printed Circuit Boards

by Steven L. Williams

Repairing or reworking printed circuit boards (PCBs) is a basic skill that every electronics technician must acquire. Most of the work involves soldering and unsoldering techniques used to mount, remove, or replace components. The only way to really learn this is through practice, but you must also have an understanding of the whys and hows.

In this article I will concentrate on a special group of PCBs, namely double-sided boards employing what are known as plated-through holes. We will begin by seeing what a plated-through hole is, and determine where and how it is used. Next will come a survey of tools and a discussion of methods for soldering, unsoldering, and repairing plated-through holes, with emphasis on good workmanship.

WHAT IS A PLATED-THROUGH HOLE?

As you may recall from your regular NRI lessons, a plated-through hole in a PCB is a hole that has had a conductive material deposited around its wall. The conductor is deposited by an electroplating process, and forms a solid, metallic connection through the hole from the copper foil pad on one side of the board to the pad on the opposite side. Glass fabric epoxy materials are best for boards with plated-through holes.

First the conductive pattern (traces and pads) is produced, usually by etching away the unwanted copper. Next, the holes are drilled or punched. Finally, the plating is deposited in all of the holes. Figure 1 shows a cutaway side view of a typical plated-through hole.

Let's take a look at what a plated-through hole is good for. Figure 2 is a cutaway view of a PCB, showing a 14-pin DIP IC (dual in-line package,

www.americanradiohistory.com

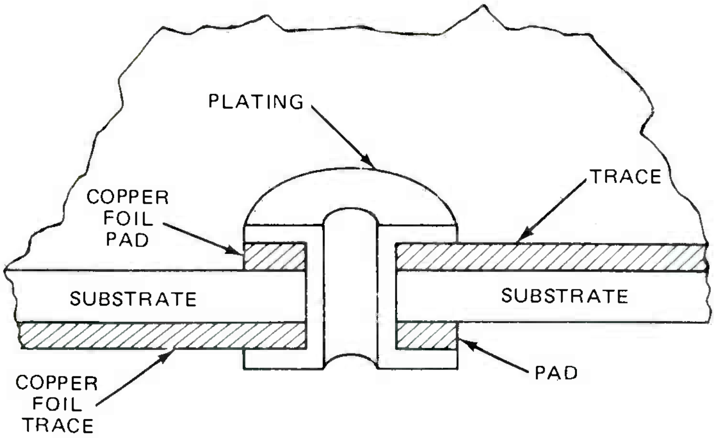


FIGURE 1. A PLATED-THROUGH HOLE WITH TRACES ON EITHER SIDE OF BOARD.

integrated circuit) from its end. The various connections to its two extreme pins, numbers 1 and 14, are shown here in order to illustrate how plated-through holes are used in practical circuits.

Beginning from the left, the V_{CC} bus connects to pin number 14 of the 7400 IC via trace C, hole number 1, trace B, and hole number 2. In this circuit, hole 1 is used merely as a connection between traces B and C. This was necessary in order to cross traces A and D, both of which run at right angles to B and C. You will see this done a lot in practical printed circuits because it is often impossible otherwise to get around an obstruction.

The other pin, number 1, is an input to a NAND gate in the IC. It is to be held high by the pull-up resistor. The connection between pin 1 and the resistor goes from hole 3, along trace E, to hole 4.

Glass fabric epoxy boards are expensive. Plated-through holes add considerably to the cost. In digital equipment, these boards will likely be crowded with DIP ICs. Such boards, with their numerous narrow copper foil traces on both sides of the board, are

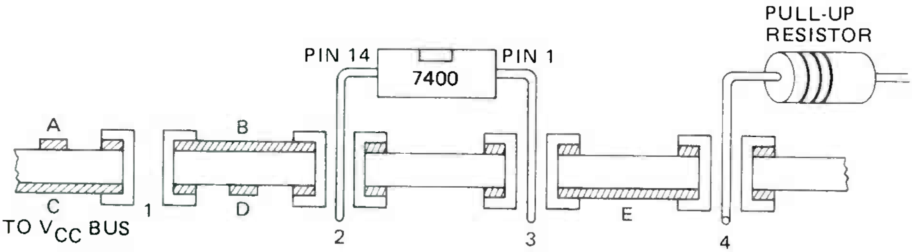


FIGURE 2. HOW PLATED-THROUGH HOLES ARE USED.

www.americanradiohistory.com

very prone to accidental damage during any repair process. Plated-through holes complicate the job even more. So now we will see how to handle this work properly and save boards.

FIRST THINGS FIRST

There are certain principles of good workmanship you can learn that will help you to work skillfully with only a minimum risk of damage to those costly boards. It takes time to develop a sure hand. If possible, get some scrapped boards to practice on first. Even experienced technicians will do well to practice on a few scrapped boards when learning to use a new desoldering tool.

Keep your desoldering tools in perfect shape. Gradual wear of these tools usually goes unnoticed until the tool is nearly useless, or perhaps ruined. Regular (daily) periods for preventive maintenance of your tools will help ensure their long life. At such times you should clean or replace soldering tips, clear air paths, and clean filters in solder-sucking tools.

When your tools begin to wear, you will begin exerting more pressure on the working area, and you are likely to use more force and heat than normal. Also, the work will not be as clean and neat as it should be, and it gets harder. Watch for these signs. Then take time to get your equipment in shape before you start wrecking those costly boards.

The first thing you'll notice about a plated-through hole is that it doesn't solder (or unsolder) like ordinary surface solder joints. You have to apply heat to the joint for a longer time while the solder runs up the hole in a wick action. You know you have a good joint when the solder will run up the hole and start climbing the component lead on the opposite side. Figure 3 illustrates this effect.

Remember that too much solder causes shorts on the component side of the board. We'll discuss this more thoroughly later on.

Now when unsoldering, the opposite occurs. That is, you want to get the solder to quit the component lead and vacate the hole, as well. If you don't get all of the solder out, the remainder resweats the component to the hole, and you'll yank out the plating along with the component. More about this later.

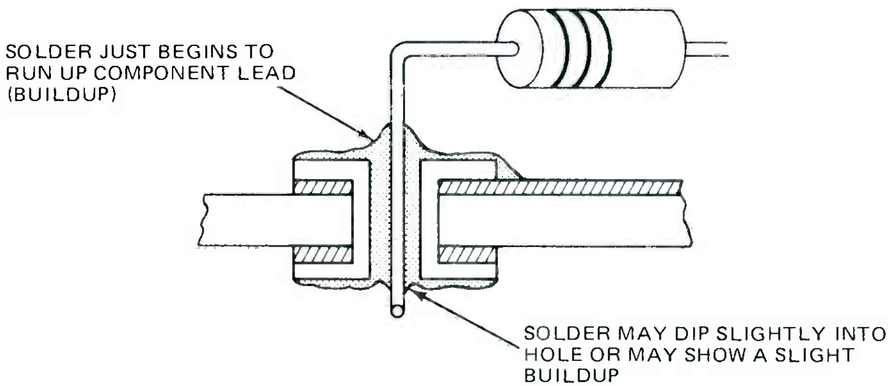


FIGURE 3. A PROPER SOLDER JOINT.

www.americanradiohistory.com

Table 1

Desoldering Tools and Aids	Remarks
Soldering iron and solder-sucker	Simplest method. Works well enough. Frayed tips leak air when doing one pin at a time on ICs, but new tips are cheap. Apt to spray shreds of solder about, causing short circuits.
Desoldering braid	No good for plated holes. Heat doesn't transfer well enough to melt all the solder in a hole.
14-pin and 16-pin DIL desoldering tips (branding irons)	Removes ICs fast (needs a steady hand) but does not clean holes. One slip and you can chew up a lot of thin traces. Most technicians I know prefer not to use this method.
Vacuum tools such as Pace Sodr-X-Tractor® or Weller DES-102 desoldering iron or Edsyn Model DSO17	Usually best to work with. Can normally remove all solder and clean hole in one operation, but only one hole at a time. At first, difficult to use correctly until practice makes perfect. Requires daily maintenance. Most expensive method.
IC inserters/pullers	Inserters fine for inserting ICs. Helps prevent bent pins. But when it comes to removing desoldered units, I have mixed emotions! Once I have all the pins clear of the hole wall, I prefer to slip a strip of cable tie underneath the IC and pull it out that way.

TOOLS

Table 1 lists my personal evaluation of the desoldering tools normally in use today. I have had actual experience with all of these techniques except the Weller. I have never worked with a DES-102 myself, but I have watched several operators use it, and it seemed to work very well. At work I use a Pace machine which I like very much. At home, I use the iron-and-sucker method. If you've never used a vacuum tool before, Fig.4 shows you the principle.

The tool shown in Fig.4 uses a hot, hollow tip. The heat melts the solder, then vacuum is applied through a tube in the opposite end and the solder is sucked away in the direction of the small arrows inside the hollow tip. The solder is gathered in a receptacle that must be emptied regularly or the tool will clog. Several companies make tools that work on this same or a similar principle.

At first, I found it very hard to use this type of tool. After two or three weeks, however, I finally got the knack. Most of my trouble was due to ignorance. I hadn't bothered to read the instruction manual carefully, and was neglecting to select the correct size tip for the job. Nor was I cleaning the machine properly.

REMOVING COMPONENTS

Always bear in mind that the PCB itself is the most expensive component in the circuit. Occasionally, you'll get into a situation where "something's got

www.americanradiohistory.com

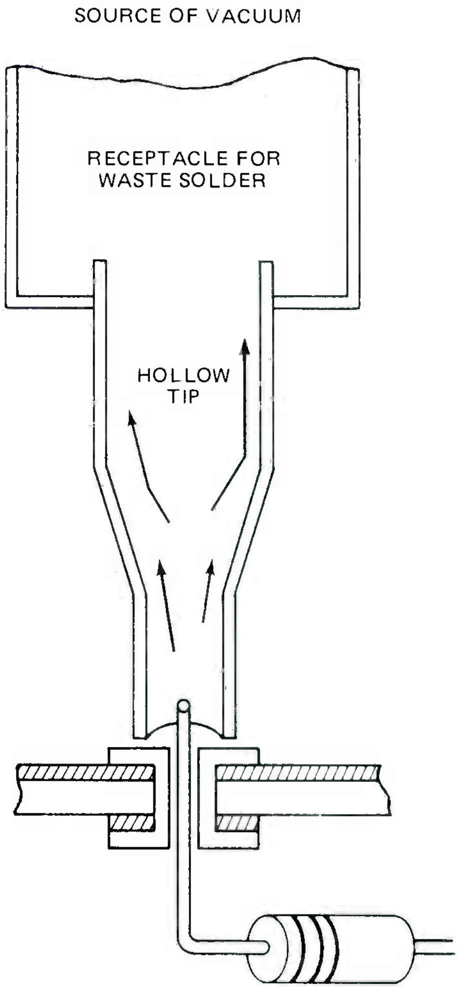


FIGURE 4. VACUUM-OPERATED DESOLDERING TOOL (PRINCIPLE).

to give." When you do, make certain it's not the board that gives. Usually you can sacrifice almost any component in order to save the board.

Sometimes I catch myself stupidly struggling with a perfectly good PCB in order not to damage the faulty part that I'm trying to remove. If there is a reason to unsolder the part in the first place, why not be willing to damage it a little (or even completely) if it looks as though the operation otherwise could harm the board? Why was I removing the part anyway? Don't be afraid to mangle a part if that's the best way of getting it out.

But when you do decide to cut a component away, there is a right way and several wrong ways of doing it. As a general rule, always cut the leads as close to the component body as possible. In other words, cut a lead as far away from the solder joint as you can. Whenever you cut a lead, you give the plated-through hole and connecting foil a mechanical shock. The heavier the lead, the greater the shock. Incidentally, when cutting IC leads all the way up to the housing, the mechanical shock will probably shatter the plastic housing. Just make sure you clean up all the pieces so you don't leave any shorts around.

Once you have cut the component free, straighten the leads so you can suck them away along with the solder in the hole. Still, cut only those parts that won't come out the normal way!

Now a word about heat. Heat loosens the bonding between foil and substrate. So always allow plenty of time for a joint to cool off between soldering/desoldering operations.

CLINCHED LEADS

Equipment designed for rugged use may have the component leads bent flat against the pads on the solder side before being soldered. This is called "clinching." You have to be especially careful when unsoldering parts with clinched leads. The difficulty is that it is nearly impossible to clean away all the solder from the joints. There will almost always be some left underneath the lead, causing a sweat to the foil. If the leads are rigid, you risk tearing out the

www.americanradiohistory.com

pads if you try to unsolder and then straighten the leads. The easiest thing to do here is to clip the leads on the component side and then suck them through the hole, as described previously.

Where you can't get at the leads to cut them from the top side, try one of these two suggestions:

1 For transistor and signal diode leads, thin resistors and capacitor leads, and light wires, refer to Fig.5:

a Touch the hollow tip of the desoldering iron to the tip of the lead. Try to avoid touching the pad. *Use a thin tip!*

b As the solder begins to melt, slide the desoldering tip more and more over the lead, while you lift and straighten.

c When the lead is straight, go right over into the normal desoldering operation by applying vacuum as soon as all the solder in the hole melts.

2 For heavier leads that won't readily bend, or if you're using the solder iron-and-sucker method, refer to Fig.6:

a Remove the solder as well as you can.

b Slowly work miniature cutting pliers between the lead and pad, patiently snipping through the solder sweat until the leads snap free. (You can both hear it and feel it.) Then bend the lead gently away from the board with the closed plier jaws. Watch the foil – be careful not to tear it off the substrate.

Once you work the clinched lead free, you may find that the lead still sticks to the hole wall. With the lead straightened out, resolder the connection and – after a cooling period – unsolder as described in the next section. Even with all this care, there is still danger of ripping the pad loose, but it's still a lot safer than trying to pry the leads free with a knife blade in one hand and a soldering iron in the other. That would be a very accident-prone method indeed.

Clinched IC leads require great care because they are packed so closely, and their pads are often very fragile. However, IC leads are easy to bend, and the method shown in Fig.6 works quite well.

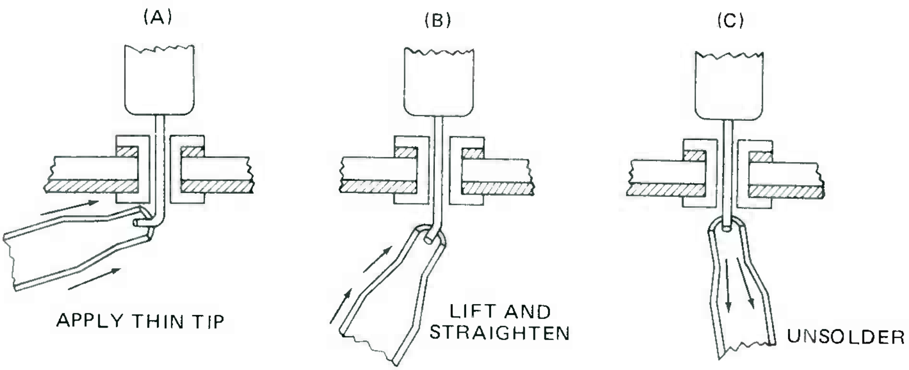


FIGURE 5. UNSOLDERING A CLINCHED LEAD.

www.americanradiohistory.com

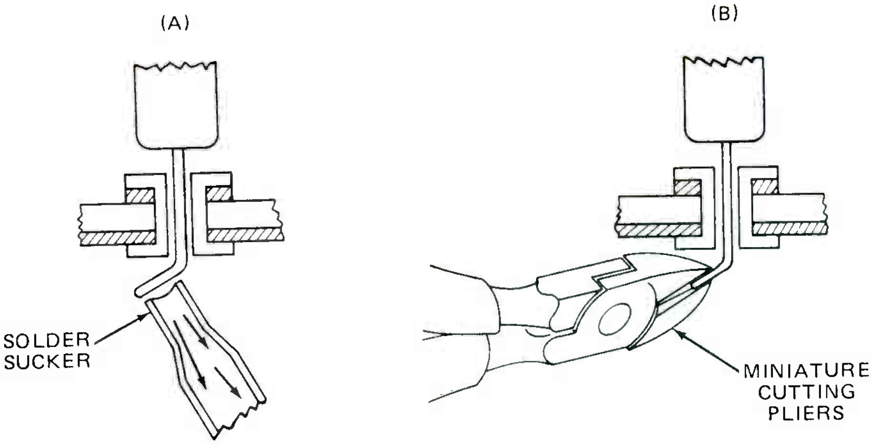


FIGURE 6. ALTERNATE METHOD OF UNCLINCHING A LEAD.

THE ART OF UNSOLDERING

It would seem that by now we have covered all there is to know about unsoldering. Believe it or not, there are still a few "tricks of the trade" that we ought to consider. Most important, let's look into the subject of heat.

Every technician has to learn how much heat to apply for each job. I will only point out here that too little heat will have you pushing and twisting your iron. That amounts to physical violence and is dangerous to circuit boards and fingers. Too much heat, on the other hand, lifts pads and traces, scorches boards, and zaps semiconductors.

Heat transfer from the soldering tool to solder joints should be via the component leads and the solder, not pads and hole linings. Often I start by adding a drop of fresh solder to a joint before unsoldering. This helps transfer the heat quickly. (It is a good trick when unsoldering a DIP IC with a branding iron tip.) Hold the iron so as to apply most of the heat toward the component lead, and only enough heat to the pad area to melt the solder there. Watch the other side of the hole. When the solder melts all the way up, apply the suction to suck the hole clean.

Once the hole is sucked clean, lift the component lead away from the pad with the hollow tip. Then, while still applying vacuum, wiggle the lead around in the hole. This action cools off the lead while it is in motion and it won't resweat to the hole wall.

If you don't get the hole clean on the first try, *never* try to reheat it. With most of the solder removed, there's no way you can get enough heat to the remainder without damaging the foil or the hole plating. Instead, let the joint cool down, then fill the hole up with fresh solder. (Don't be too stingy.) Let the joint cool off again, then unsolder once more, allowing enough time for all the solder to melt before applying vacuum again.

If you're using a soldering iron and a solder-sucker, once the solder is removed, try to jiggle the lead back and forth in the hole with your fingernail until you feel and hear it snap free. Then you can safely – though still gently – pull the component out.

As you know, proper unsoldering is even more demanding than soldering,

www.americanradiohistory.com

although you certainly have to keep your wits about you even when making a "simple" solder connection. Let's take a look at what we should expect of a good solder joint.

SOLDERING A PLATED-THROUGH HOLE

The first time you ever solder a plated-through hole, you're in for a surprise! Keeping the soldering iron tip on one side of the component lead, and applying solder to the other side, all goes as expected. The solder begins to flow around the lead and pad area nicely until . . . whoops! Suddenly the solder drops down the hole. That's when you know that you're doing a good job. Apply just a little more solder so the hole fills up. Afterward, look at the joint from the component side. The solder should look like it's trying to leave the hole by crawling up the lead in a smooth, wick-like action.

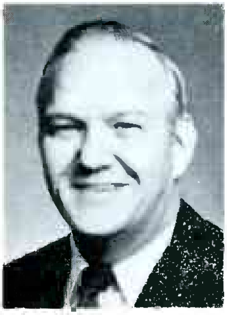
The solder shouldn't clump anywhere. If the solder has flowed through the hole correctly, there is a good, large area of mechanical and electrical contact between hole wall and component lead. There will be a natural swell of solder on the component lead, which is plenty. Solder should also flow slightly around the pad area, reinforcing the connection between foil and plated-through hole. There is no need to pile up more solder outside the hole, where it does no real good, and may in fact cause a solder bridge to an adjacent pad. Look again at Fig.3.

In this article, I have tried to avoid repeating information already contained in the regular NRI lessons. Most of the procedures and methods recommended here are based on advice from toolmakers or instructions from production and quality assurance engineering manuals. Some things I have just picked up by myself, or learned from fellow workers. I hope that I have introduced a few ideas that can upgrade your skill and increase your worth as an electronics technician.

1	Conditional Class License eliminated. Novice power limit upped to 250 W.	June 25, 1976
2	Technicians given Novice privileges.	July 23, 1976
3	No new distinctive Novice call signs, although Novices may sign "/N."	October 1, 1976
4	No requirement to sign "portable" or "mobile" except foreign operators using reciprocal licenses.	November 26, 1976
5	First "comprehensive" cw exam given in Washington, D.C. office. No solid copy for one minute requirement.	January 1, 1977
6	Court case "temporarily" suspends all license fees.	January 1, 1977
7	New interim licenses issued upon upgrade of license class at an FCC office.	March 1, 1977
8	Secondary station licenses eliminated.	March 3, 1977
9	97.95(a)(2) deleted. no notification of new address required.	March 9, 1977
10	New emission purity standards. All spurious emissions down 40 db for transmitters operating below 30 MHz, down 60 db for transmitters of 25 watts or more operating between 30 MHz and 235 MHz (97.73).	April 15, 1977
11	Code sending test deleted from Commission-administered examinations.	August 26, 1977
12	97.95(b)(2) rescinded. Maritime Mobile in Region 2 may use all amateur frequencies. In foreign waters may use only frequencies authorized by regional government.	September 12, 1977
13	Call sign restructure making special calls available to various class license holders.	March 24, 1978
14	Ban on commercial 10-meter linear amplifiers.	April 28, 1978
15	Novice license term extended to five years, renewable. Technicians given full privileges above 50 MHz.	May 15, 1978

www.americanradiohistory.com

Ham News



Ted Beach
K4MKX

You know, I guess it has been almost ten years now that there has been a Ham News column in the *NRI Journal.* That's really hard for me to believe, even though I was not involved with the first few columns 'way back then. In fact, I guess the first mention of amateur radio in these pages could not really be considered the start of a column as such, since the main purpose at the time was to get the names and addresses of amateurs who might be willing to help out with Novice tests for our then brand-new Amateur Licenses course.

It was about that time that the first suggestions of forming some kind of NRI net started coming in. Nothing much was done for a year or so, but as more and more people expressed an interest in a net, someone finally actually volunteered to do something about it. As I recall, it was set up on 20 meters (which left out the Novices!) and two or three nets were actually held. Then things sort of dried up and little else was done.

In going through the mail for the column this time, I was struck by the number of people writing once again asking about an NRI net. Well, maybe it's time to give it a try again. I would suggest that a frequency be selected that would include Novices (and Technicians) as well as Generals, Advanced, and Extras. This would put it on cw for a start, and would mean 80 meters, 40 meters, 15 meters, or 10 meters. Since NRI students and graduates are spread out all over the United States as well as the rest of the world, we should pick a band that has some chance of providing fair coverage around the globe. (Wishful thinking!) This would pretty much rule out 80 and 40 for those of us who don't have huge antennas and lots of power to compete with the QRN and QRM.

Old Sol, behaving as he is supposed to in the coming months, would make

www.americanradiohistory.com

15 or 10 a fairly decent choice. Both bands open up quite frequently these days, and stay up for some time. Besides, when things are going right, a dipole and 10 watts can sound like a kilowatt driving a four-element Yagi on 10 meters!

The problem, of course, is to try and coordinate a suitable time, date(s), and frequency. Just to sort of start things off, I will propose that we try 28.060 MHz on Tuesday, January 16 at 2000 (8:00 p.m.) Eastern Time. That's long enough after the first of the year for everyone to be recovered. *No* time will be convenient for everyone.

I'll be on and will call "CQ NRI" and see what happens. I still have only a vertical, so I should get out equally poorly in all directions (Hi!). If you don't hear me, try calling "CQ NRI" yourself – maybe someone else will hear you and respond. Who knows, it just might work!

After that trial, I'll wait for your comments and report in the next *Journal*. Maybe we'll have to try 40 meters and compete with the broadcasters–I don't know. At any rate, mark Tuesday, January 16, 1979 on your calendars (8:00 p.m. Eastern) and listen up on 28.060 MHz for a first effort.

Now, I think we will introduce you to a minicontest. To sort of go along with the NRI net idea, we have been thinking that it would be nice to have some NRI QSL cards as well. Actually, the QSL cards will be used as a sort of graduation present for students of the Amateur Licenses course who successfully get an amateur license as a result of their NRI course training. At the same time, we just might make these cards available to any NRI student or graduate for a nominal payment.

At any rate, the contest part is for you to submit a card design idea for our judges to consider. We don't have much in the way of prizes, but the winner will get the first hundred cards off the press, and will receive a free one-year membership in the NRI Alumni Association.

You don't have to be an artist. A sketch will do nicely. We would like to have the NRI initials displayed somewhere on the card, and we thought perhaps we might use the world/electron symbol that heads the Ham News column as well. One other thing: in order to make the cards as inexpensively as possible, yet allowing a two-color printing job, we would like the cards to be one-sided. That is, everything on one side of the card only. If you just can't seem to make one like that, we might consider one with printing on both sides. However, first preference will be given to those entries having a design on one side only.

You can send your entries to me in care of the *NRI Journal*. We will notify the winner as soon as a reasonable time has passed for you to get some designs in to us. Just to set a date, let's say that all entries must be received no later than the last day of March, 1979. Good luck!

Now let's see who we have heard from since last time. As you can see, there are quite a few this time. And would you look at some of those calls! I don't think I'll ever get used to some of these new-fangled ones. Field Day just about drove me bananas this year! How about AC8F, for example or N4ACB? Like, wow! Oh well, I guess I'll have to learn to live with them. I can say one thing, though. If and when I ever get that old Extra ticket, you better believe I'm hanging on to my one and only original call. . . K4MKX.

Sort of got sidetracked there, so now on with the show.

KA2ACV wrote two notes to us. The first told of his acquisition of the Novice license and gave details on the station. Tom built and uses the SB104A with its power supply into both a horizontal vee antenna and a 4BTV

www.americanradiohistory.com

Robert	KA1AWK	N	Augusta ME	John	WA2SUJ	A	Pennsville NJ
Tom	KA2ACV	G*	Highland Mills NY	Earle	K2YEF	–	Boston MA
Martin	W2FEI	–	Cedarhurst NY	Mike	K3MXO	T	Pittsburgh PA
Judy	WB3GRT	G*	Carlisle PA	Mike	N4ACB	–	Ashville NC
John	WB3JYQ	T	Laurel MD	Robert	KA4BSW	N	Helenwood TN
Davy	WB3KTS	G*	Philadelphia PA	Kenneth	KA4DAC	N	Pompano Beach FL
Eric	KA3KXV	N	Harrisburg PA	Vi	WD4EIY	N	Sumter SC
Danny	WD5ILW	N	Vidor TX	Dan	WD4PIQ	E*	Mayport FL
George	WD6GLP	N	Buena Park CA	Maurice	WD4RGU	N	Norrisville NC
James	WB6IVR	A*	San Pedro CA	Rick	WD6GYL	N	Mission Hills CA
Bill	WB7OJS	G*	Tempe AZ	Ted	W6RHB	A*	Buena Park CA
Reiner	WB7UCU	N	Williams AZ	George	AC8F	E*	Muskegon MI
John	WDØEDY	A*	Worthington MN	John	WD9HGV	G*	Berwyn IL
Sammy	KA1BDM	N	Westerly RI	George	WD9JIC	N	Hayward WI
Roger	WB1FHX	G*	Agawam MA	Ray	KBØAN	A*	Lake Crystal MN
Rick	WA1WPR	T*	Berwick ME	Yasuo	KH6JQT	N	Honolulu HI
Greg	KA2ATW	T*	Albany NY	Peter	VE4AEZ	–	P. La Prairie, Manitoba
Peter	KB2CU	A*	Albany NY	Jan	ZS6BMN	–	Transvaal SA
Al	AA2H	E*	Princeton Jct. NJ				

*Just upgraded—congratulations!

Hustler vertical, up about 25 feet. The second note was to tell us he had passed the General test, but missed the Advanced by one or two questions. Tom said he was going to try again in November, and might even go for Extra.

W2FEI wrote asking us a question that I completely forgot to research and answer. Marty has an old monitor scope (Heath HO10) with a bad crt socket. After checking the 3RP1 pin out, it would appear that the problem is probably just a bad socket, Marty, and if and when you replace it, I would suggest removing the parts from pin 11 (the tie point) to reduce the possibility of arcing in the future. If a new socket doesn't do the trick, you probably have a bad crt.

Judy, WB3GRT, writes that her dad first got her interested in Ham radio some 19 years ago, but it wasn't until 1977 that she got her first ticket—the Novice. Now, after some NRI studying, Judy has received her General. She has a TS520 transceiver, a Hygain 18AVT vertical, and uses a Heath keyer on cw. Judy is also active on 2-meter FM with an IC-22S into an 11-element Yagi. In addition to amateur radio, she has a real interest in raising exotic plants such as the Venus-flytrap, pitcher plants, passionflower vines, and the like. Fine business, Judy, and we will certainly be looking for you on the dc bands.

WD5ILW says that he certainly enjoys his new Novice ticket, and he is looking forward to taking the Technician test in the very near future. At the present, Danny is using a secondhand SB102 along with various dipoles, but plans to get some 2-meter FM gear as soon as he gets the new license. His Novice ticket took only six weeks to be issued after he sent in the exam.

WB6IVR is a recent graduate of our Amateur License course. As a graduation present to himself he went down to the FCC office and passed his Advanced test. Nice going, Jim. He also is a "home-brew" artist and liked the ramblings in the last Ham News column on that subject. Jim's first project was a keyer for his Heath SB104 transceiver, and he says he is looking forward to more projects in the future.

Bill, WB7OJS, just upgraded to General, and says he completely forgot to let us know when he first got his

www.americanradiohistory.com

Novice ticket. His shack has some real old-timers in it: a Mulit-Elmac AF-68 and a Mosley CM-1. Wow, I can remember drooling over these pieces of equipment when I first got my license back in 1951. They were brand-new then, and I always thought it would be neat to have a mobile transmitter (the AF-68) and receiver so I could work both mobile and fixed with the same gear. Today, most transceivers are set up this way, so big deal! Anyway, congratulations on the upgrade, Bill, and take good care of that gear!

WDØEDY first appeared in these pages in the May/June issue. Now John is back to tell us of his upgrade to Advanced Class as of April. Nice going, John, and we wish you the best on the Extra. Let us know when you make that one too.

WB1FHX keeps pretty busy these days. In addition to his NRI studies (Communications), Roger has been studying for the General license, which he just got, and is going to college full-time. Now, he is sort of stuck on 10 meters with his TS520 (with outboard digital display) since the only antenna he has is an old 11-meter job he "converted" to 10 meters. Roger says he was quite surprised when he made contact with a DK8 for the first time. Anyway, as soon as all the studies are out of the way, he is going to erect some more antennas just so he can try out that nice transceiver and get on 2-meters with the NRI Model 452, when he completes it.

KB2CU writes that as a student of the Communications course he had been reading the *Journal* and the Ham News column for quite some time before the ham bug bit him, but when it bit, it bit hard! After studying the Morse code from some cassette tapes, Peter went down to the FCC and got his Technician, Advanced, and Second-Class Radiotelephone licenses. Unfortunately, the new ham licenses meant he had to try out some new gear (TS820) so the NRI studies have sort of fallen by the wayside. Peter assures us that he has not dropped out. He's just resting and will hop to the books any day now.

WA2SUJ was one of the several respondents who asked about the possibility of an NRI net. John has been a ham for several years and at present is using a Heath HW101 with a home-brew antenna tuner into a random-length wire antenna. He also has a TR22C on 2-meters, but is looking forward to completing the Model 452 later in his course.

On September 8 I got a phone call from Mike, K3MXO. We must have talked for the better part of half an hour, and I'm sure glad I don't pay his phone bill! Mike is recuperating from a recent operation and just thought he'd call. He indicates that perhaps his greatest interest in ham radio is home-brewing. We went on and on about the old WW2 surplus gear (ARC5s, etc.) and how different things are today. Mike is presently waiting for a power transformer so he can get a GRC9 transceiver on the air. This unit will put out 50 to 60 watts, which is more than enough for Mike. For a backup receiver he has an R392. Presently he listens on this one using a 75-foot 3/4 loop antenna strung around the inside of his attic. Mike's other interests include microcomputers (he has four different ones!) and radio-astronomy, and he would love to hear from anyone else who shares his interests. You can write Mike at: Mike Tauson, 7820 Roderich Drive, Pittsburgh PA 15237.

N4ACB writes that he got his ticket in June and operates on 80 and 2 only. On the former, Mike uses a TX-1 Apache, while on the latter he uses an HW-202 into a five-element quad. If anyone would like the details of his home-brew quad, send a self-addressed,

www.americanradiohistory.com

stamped envelope to him at: Mike Baldwin, 22 Spring Drive, Asheville NC 28806.

WD4EIY writes that she and her husband (WD4EIX) are both Novices, working for W.A.S. and W.A.C. while also working to upgrade to Technician. Violet asked me a question that I have not been able to find an answer for so far. Can a single QSL card from a DX station be assigned to both operators (Vi and her husband) and count for W.A.S. and W.A.C. credit for both operators if both operate the station in the course of the QSO? It would be up to the ARRL, of course, but strictly speaking I would be inclined to say "no," the reason being that your calls are Station Licenses, and you both apparently use the same station equipment. It would be the same as your going to a friend's house and both using his (her) rig for the QSO with DX stations, both operating under your own call. I don't think that would be quite right. Your best bet would be to get a ruling from the ARRL, Vi.

Dan, WD4PIQ, tells us that he is a Navy man and presently lives in a mobile home down in Florida. Such restrictions notwithstanding, he finds the room for a 40-meter vee, a 4-MHz vee for MARS, and a 4BTV vertical on his small lot. In addition, Dan has a collinear and two 11-element beams working on 2-meters and a 2-element tri-band quad! Let's not hear any more about space restrictions! Inside the trailer, Dan has a Heath HW-101 with phone patch and a Clegg FM27B for 2. In the car, he uses a Wilson 1402SM on 2.

If any of you out there are employees or ex-employees of an airline, there is a group known as the International Association of Airline Hams (IAAH), of which WD4RGU is an active member. Maurice invites any NRI types who might qualify to join them by writing to the Secretary, N4VD: IAAH c/o Carl Crumley, 512 N. Harrison Avenue, Cary NC 27511. Maurice says that N4VD was instrumental in helping him to get his Novice ticket and in spurring his interest in amateur radio.

W6RHB says this is his third station license, and he got it when he recently upgraded to Advanced Class. Ted runs a TS520 into an all-band "vee beam" using a home-brew coupler. The antenna is fed with 500-ohm open-wire (balanced) feed line, an almost forgotten scheme these days of coaxial cable. I agree, Ted, and think balanced lines are great too.

AC8F says his new Extra call has been creating quite a stir on the bands since he got the call back a few months ago. I'll bet it does, George. One of those new "funny" calls!

Some time ago, Harry, W9ABF, wrote asking for information on marine stations operating in the 500-kHz band. Rm/3 Scott C. Morris saw his request and very kindly sent him all the information he needed, so Harry is pleased with the results he got from the *Journal* request, even though Scott was the only one to reply (outside of me, and I was not able to give him all that he needed). I'm very glad you got what you needed, Harry, and good luck chasing those ships!

KBØAN writes that his studies have suffered drastically since he got his Ham ticket. I know what you mean, Ray – it happens to all of us. He got his ticket back in April, and bought out the station of a local Novice (Heath DX-40, Moeley CM-1) and hasn't been quite the same since. After having the Novice ticket only a month, down he went to take the Technician, General, and Advanced tests. With this new stature the old rig had to go, and in its place is a Drake TR4 he uses with a Butternut HF5V-II vertical. Ray liked the antenna

www.americanradiohistory.com

so much he went to work for the company that makes them and helps put the things together.

Take a look at all that DX at the end of the list. I know this is the first time I've had a ZS call, and the KH6 is perhaps the second in ten years. First, however, is VE4AEZ, Peter, who writes that he is a brand-new amateur (May 1978). He uses a Heath MT-1 transmitter and a "much revamped" BC-348B receiver on 80, 40, and 20 cw.

KH6JQT has had his license a year, but has only been operating for about six months. Yasuo likes 15 meters best and has only a whip antenna sticking out the window on the eleventh floor in a 32-story apartment building. He says the rf feedback is so bad he can run his SB104 to only 20 to 50 watts. That's real tough, Yasuo. Maybe you should try a wire dropped down the side of the building.

Last on the list, but by no means least, is ZS6BMN, Jan. Jan writes from South Africa that he is just about to complete the Communications course, and is looking forward to converting the Johnson CB receiver to 10 meters, a worthy project. In the meantime, he operates all bands from 160 to 10 with a multi-band dipole using some real fine equipment: KW-202 receiver, KW-204 transmitter, and a Drake SPR-4 receiver. His Heath SB-200 linear is seldom used. Jan's latest "kick" is working OSCAR 7 and 8 on *all* modes. The equipment used for this consists of a Yaesu FTL21R for two-meter operation, an Argonaut and Microwaves module transverter for 432 MHz and various exotic antennas for 2, 10, and 70 cm. Sounds very impressive, Jan, and I only wish that I had more experience with such operations. Just one more facet of Ham radio that I'll have to investigate one of these days.

Well, that about wraps it up for this time. Do consider the NRI net idea, and join the QSL design contest as soon as you can. I'll be looking forward to hearing you, and *from* you. Very 73, Ted – K4MKX

THIS SPACE CONTRIBUTED BY THE PUBLISHER

www.americanradiohistory.com

Honors Program Awards

For outstanding grades throughout their NRI courses of study, these May, June, and July graduates were given Certificates of Distinction with their NRI diplomas.

WITH HIGHEST HONORS

Kenneth D. Anderson, Goderich ON Canada
Thomas Arbutiski, Natrona Heights PA
William L. Austerman, Richmond IN
Jerry S. Bannon, Fort Pierce FL
George M. Bentzel III, Moorestown NJ
Michael R. Berry, Mounds View MN
John R. Best, Hamburg NY
William L. Bickford, Somersworth NH
Robert J. Boyle, Portage IN
Paul H. Brenzel, Yonkers NY
Leonard Bress, Wallingford CT
Donald L. Bryson, Thornton CO
Francis O. Burgoyne, North Woodstock NH
Ray Earl Cartwright, Cape Canaveral FL
Richard T. Cherry, Beaumont TX
Frederick E. Clague, Jr., FPO New York
Kenneth G. Clark, Annapolis MD
James Alton Cozby, Denton TX
Dale Cregeen, Rockford IL
David T. Cretty, Laurel DE
Terry H. Daniels, Staten Island NY
Charles Driver, Jr., Oakton VA
Ralph C. Eberly, Pretty Prairie KS
Charles D. Ellis, Lake Charles LA
Vincent J. Fulton, Ewa Beach HI
Stephen H. Gheen, Cloquet MN
Theodore L. Giles, Othello WA
David H. Grundies, Virginia Beach VA
Larry Richard Haas, San Antonio TX
Carl E. Hart, Springfield OH
Donald K. Hileman, Man WV
Edward Howard, Garrett IN
Arthur Louis Hubert, Chicopee MA
John C. Hucko, Palos Hills IL
Dale R. Humphrey, Circleville OH
Geoffrey B. Hunter, Oak Harbor WA
Donald F. Kennebeck, East Camden AR
Albert J. Kern, Philadelphia PA
Norman L. Kissell, Moores Hill IN
Donald W. Klaus, Plainville KS
Sadhu Singh Kundi, Middlesex England
Earl E. Leas, Jr., West Reading PA
John Maki, Duluth MN
Joseph T. Manna, Brooklyn NY
Lance C. Maser, Au Gres MI
Stephan A. Miller, Jr., Schenectady NY
Charles J. Mullen, Wallkill NY
James M. Nadeau, Tacoma WA
Jerry Don Neessen, Brooklyn NY
Michael R. Newcomer, La Paz IN
Mark Arthur Owens, Saint Louis Park MN
Leon B. Pace, Jr., California MD
Jim W. Perry, Mesquite TX
John Petriello, Ramsey NJ
James D. Porter, Albion IL
G. Howard Poteet, Cedar Grove NJ
Herbert Arthur Randall, Cheshire MA
Michael E. Roberts, Saint Charles MO
Ole Salazar, Silverton CO
Lyle Allen Schmuhl, F E Warren AFB WY
Wayne D. Schwab, Ivoryton CT
Gilles Sergerie, Cap-Chart PQ Canada
Duane J. Sitte, Sister Bay WI
Lloyd E. Stambaugh, Jr., Hixson TN
Donald P. Stein, Bethesda MD
Raymond Eugene Sylvester, Hamden CT
Richard Leon Thomas, Circleville OH
Robert D. Ungaro, Niagara Falls ON Canada
Archie Van Horn, Benton IL
Fred Wengler, Bohemia NY
William C. Wiggs, Levittown PA
David Yapkowitz, Los Angeles CA

WITH HIGH HONORS

Gregory M. Adkisson, Ely MN
Charles R. Albury, North Lauderdale FL
Douglas A. Alexander, Racine WI
Bradford S. Amidon, Petersham MA
Edward Peter Amundsen, Brooklyn NY
Gerald Anderson, Waterloo NY
Raymond F. Appleby, Dunnellon FL
Otto L. ARanda, Bayamon PR
Charles E. Armacost, Jr., Idalou TX
Wallace G. Armstrong, Clarksville TN
Eugene Aro, North Vancouver BC Canada
John Thomas Astrom, Oscoda MI
Kenneth Lee Ayers, San Jose CA
Sofronio P. Babula, Windsor Locks CT
Lewis A. Barnard, Marlboro NJ
Frank Bartlett, Tonawanda NY
George V. Baskett, Otis AFB MA
Charles Richard Bear, Shermans Dale PA
Charles R. Beatty, Fredericksburg VA
Ernest V. Bell, Westville NJ
Richard P. Bendler, Roxbury CT
Kenneth M. Berg, Mobridge SD
Walter T. Blansett, Jr., Norfolk VA
Charles E. Boatwright, Shelby AL
Francis J. Bolmanski, Erie PA
Joseph P. Borden, Jr., Bronx NY
Daniel A. Boudreau, FPO New York
Howard Boutcher, Oshawa ON Canada
James Roger Brackin, Town Creek AL
Paul Bradley, Delaware OH
Arvel O. Bradford, Bucyrus OH
Bobby Don Brandon, Stuttgart AR
William G. Branick, Hughesville MD
William R. J. Bricker, Ellsworth KS
Robert Louis Brodeur, Huntsville AL
Robert Burkhardt, Jr., Morgan Hill CA
Ferguson J. Byars, Sun Valley CA
Michael Cahill, Bowmanville ON Canada
Robert John Cardinali, Warren OH
Donald Carr, Meadow Grove NE
James Henry Cason, Wildwood FL
Raymond J. Cayot, Warren OR
Frank Cebollero, Brentwood NY
Wayne A. Cecil, Massillon OH
James Chapman, Sweetgrass MT
Michael J. Christian, Harvey LA
Don P. Clayton, Birmingham AL
G. A. Coffman, Chester SC
Robert W. Colman, APO New York
Danny Howard Cooke, FPO New York
N. S. Cornwell, Fairborn OH
Raymond Coronado, Los Angeles CA
Edwin Dale Cowley, Cushing OK
Robert E. Craig, Jr., APO New York
Michael J. Crane, Arco ID
Allen Lee Davis, Kouts IN
Harry G. Davison, Jr., Richmond VA
Brent Charles Dayton, Regina SK Canada
Richard S. Deeds, Jr., Morgantown PA
James J. Dervie, Wyoming MN
George A. DeWeese, Belton TX
Henry Dillenschneider, East Northport NY
John Edward Dingman, Plainfield IN
Peter John Ditto, St. Ann MO
Herman Q. Doan, Jr., Brownsburg IN
Wayne M. Dodd, Doylestown PA
Thad A. Douglas, Jr., Hamburg AR
Billy R. Dowda, APO San Francisco
John M. Downey, Sudbury ON Canada
Cyrus Wayne Drake, Evansville IN
Elaine B. Drake, Frederick MD
Delton W. Drawdy, Mountain Home AFB ID
Tim G. Dudley, Rupert ID
Mark Allen Duffee, Ridgway PA
Mel Duhon, River Ridge LA
James Henry Dunbar, Birmingham AL
Boyd L. Dunn, Sevierville TN
Kenneth R. Eichin, Santa Maria CA
Carl R. Endres, Suttons Bay MI
Robert Wayne Ferrin, Seguin TX
Anacleto R. Filoteo, Jr., San Antonio TX
Millard Lee Fischer, Kansas City MO
G. Fisher, Calgary AB Canada
William A. Fisher, Elkhart IN
Ewell T. Fletcher, Jr., Rockford IL
Kermit M. Floyd, Austell GA
Jerry M. Foy, Linden MI
Le Roy C. Friess, Adrian MI
Lester T. Fykes, Flint MI
Stephen E. Galla, Sr., Phoenix AZ
Adolph Galonski, Boynton Beach FL
John R. Gaumer, Jr. Fresno CA
Rex W. Geiling, FPO New York
Nicholas T. Georgephy, Akron OH
Gordon M. Gibson, Barnegat NJ
Julian L. Gillispie, Fairfield PA
Lloyd T. Graham, Samuels ID
Howard V. Grahn, Derby KS

www.americanradiohistory.com

James D. Gras, Sherman TX
David T. Gray, Taneytown MD
Nelson R. Graybill, Jr., Roanoke VA
Elder R. C. Green, Indiana PA
Jon Edward Greene, Hartford WI
Leo V. Gross, Louisa VA
Phillip G. Grossman, Ocean NJ
Nicholas A. Guerbo, Fort Lauderdale FL
Tomas S. Guerrero, Ft. Leonard Wood MO
Lloyd A. Gustin, Jr., Dover NJ
Rick A. Hacker, Melvin MI
Roger D. Hammer, Virginia Beach VA
Bruce Hard, Kimberling City MO
Floyd G. Hastings, Granger UT
C. Wayne Hayle, Hermitage TN
Roe B. Heatherly, Jr., Tempe AZ
John M. Heaven, Grafton ON Canada
Thomas C. Hedrick, Jr., Sterling Heights MI
Ronald J. Hemmelgarn, Bremen OH
Russell L. Hersh, Emmaus PA
Robert Redmond Hite, St. Petersburg FL
Benjamin Hodgers, Pembroke Pines FL
Matthew Hodgson, Morris Plains NJ
Hubert M. Householder, Knoxville TN
Bob Hunter, Stuart FL
Joseph Inskeep, Lonaconing MD
Charles DeWayne Irey, Westlake LA
Clinton Jackson, Plainfield NJ
Murray J. Jackson, Cunningham TX
James T. Jarosz, Port Washington WI
Charles B. Jennings, Aberdeen Proving Grnds.
Bobby W. Johnson, Pasadena TX
Jon M. Johnson, Idaho Falls ID
Clarence A. Jones, Sr., Augusta GA
Dennis Orrin Jones, Grand Rapids MI
Earl Luther Jones, FPO Seattle
James D. Jones, Concord NC
Robert Earl Jones, Lemoore CA
Byung K. Jung, San Gabriel CA
Edward T. Jung, Wisconsin Rapids WI
Charles B. Juvenal, Omaha NE
James Kasperski, Long Island City NY
Ken M. Kempf, Roberts WI
Robert M. Kerr, Jr., Columbia SC
Richard C. Kerster, Olney IL
Thomas Landis Kimmel, Newport News VA
Kenneth A. King, Scarborough ON Canada
Walton J. Kitchen, Jr., Bowie MD
Kenneth Kochanski, Chicago IL
Aaro O. Koski, Wallingford CT
Stephen D. Krankowski, Oxon Hill MD
James Wallace Lambert, Holland MI
Thomas Wendell Lawlor, Tully NY
Phillip Jude Le Bas, Huntsville AL
Chew G. Lee, San Francisco CA
Robert E. Leighton, Glenmont NY
John R. Lemke, Mountain Green UT
Anthony J. Lepkowski, New Castle DE
Gilles Lessard, Churchill Falls NF Canada
Jerrold M. Lev, East Lansing MI
Carl E. Lewellen, Scottsville KY
Edwin C. Lindberg, Tacoma WA
George W. Little, Clandeboye MB Canada
Norris A. Lockman, South Bend IN
Gary J. Logue, Bremerton WA
Richard J. Lyon, Kearns UT
Gary L. Machholz, Chillicothe MO
Fred J. MacKenzie, Kingston ON Canada
Edward Paul Marchese, Staten Island NY
Joyce Marcus, Santa Monica CA
Robert C. Marley, Dorchester MA
Virgil V. Marquart, Fort Wayne IN
Robert E. Marsh, Little Rock AR
Peter L. Marzetta, Portsmouth RI
Ralph E. Manges, Roosevelt TX
John D. Mantone, Madison NJ
Robert R. Manuel, Dayton OH
La Verne F. Maseman, Aurora IL
Raymond J. Matela, Chula Vista CA
William C. McBride, Fort Lauderdale FL
Richard F. McCauley, Shullsburg WI
William W. McCrone, Holbrook NY
Claude K. McDonald, Beaconsfield PQ Canada
Glenn B. McFall, Novato CA
Patrick J. McKenna, Arco ID
Charles E. McKinzie, FPO New York
Kurt Douglas McLain, Mount Clemens MI
Wallace S. McLaughlin, Jr., Largo FL
John G. McWilliams, Houston TX
Dale E. Medley, Baton Rouge LA
John C. Meyer, North Kansas City MO
John Charles Mikulec, Fort Walton Beach FL
Jerry L. Miller, Columbus NE
George C. Minor, Middletown CT
Asman James E. Mohr, Chesapeake VA
Bryce W. Montgomery, Portersville PA
Jack Gilbert Moore, Wilmington NC
James Lee Morgan, Berwick PA
William S. Morrow, Alden NY
Daniel R. Moya, Norfolk VA
Philip G. Mullen, Glendale CA
E. Douglas Murray, Victoria BC Canada
Steven C. Nance, Houston TX
Scott J. Nesbitt, Ellenville NY
Fred E. Newton, Portland OR
Adjan James G. Nugent, FPO Seattle WA
Larry Dale Nygard, Moundsview MN
Francis Obusek, Barnesville OH
Eric Eugene Orewiler, Woodridge IL
Kenneth G. Ott, West Hazleton PA
Craig Martin Owings, Cristobal Canal Zone
Clifford E. Pace, Lawton OK
Robert Parry, Jermyn PA
Lawrence L. Patton, Fort Worth TX
Thomas A. Pawloski, Jacksonville NC
Nathaniel F. Peery, Elverson PA
Daniel R. Pelky, Mt. Clements MI
Charles W. Pell, Sr., Eustis FL
Jean-Guy Pelletier, Val D'Or PQ Canada
Frankie Lee Perdue, Three Mile Bay NY
Randy Pierce, Rayville LA
William F. Pinkerton, San Antonio TX
Thomas J. Pitre, Modesto CA
Gerald W. Powell, Covington GA
Garry L. Price, Honesdale PA
Gary D. Priddy, Encino TX
John H. Purdy, Medford MA
Alfred E. Radlhammer, Ronkonkoma NY
Alfred G. Rager, Palestine TX
Norbert D. Reed, Cambridge OH
Russell C. Reichley, Winfield PA
Joseph Reinstein, Jr., Lubbock TX
Wayne M. Remaley, Whitehall PA
James D. Richerson, Chelan WA
William P. Richardson, Baltimore MD
Ashley L. Rivers, Savannah GA
Burton N. Robbins, Grand Junction CO
Henry H. Rodal, Brooklyn NY
Delno Rogers, Stanton KY
Jerome H. Rogers, Carson CA
Frank J. Russo, Silver Spring MD
Yves Sabourin, Charlesbourg PQ Canada
Harvey L. Sachau, Rapid City SD
Jan Salat, St. Laurent PQ Canada
Carlos J. Salazar, Poste Restante Caracas
Carl Ralph Sapp, APO New York
Anthony F. Scelsi, North Bergen NJ
Robert Arnold Schaeffer, Chelsea MI
James R. Schaich, Newfane NY
Norris J. Schexnaider, Baton Rouge LA
Adolph William Schick, Thornwood NY
Frederick Schillinger, Jr., Kempner TX
David V. Schlegel, Exton PA
Jonathan L. Schmidt, Del Rio TX
James Joseph Schumm, Columbus OH
Gunther Seyffarth, Lower Sackville NS Canada
Daniel Merle Shaffer, Johnsonburg PA
Clifford S. Shipley, Clifton Heights PA
Ronald Bryce Shipman, Garland TX
Howard E. Shortt, Sparta MO
David L. Shulman, Framingham MA
Harold W. Simpson, Patrick AFB FL
Norris H. Simpson, Nashville TN
Willie Thomas Sinclair, Cowpens SC
David A. Sipes, FPO New York
Robert W. Skeet, Leaf Rapids MB Canada
Harvey E. Slaugenhaupt, Ellwood City PA
Clarence Burdell Smith, Winter Haven FL
Kenneth R. Smith, Norfolk VA
Walter A. Smith, FPO New York
Thomas John Smola, Lansdale PA
Thomas Sondi, Bronx NY
Frederick Sonnenfeld, Jr., Erie PA
Larry William Sortor, Wellington CO
Ronald G. Spangler, Big Sandy TX
Mont J. Spencer, Henderson NV
Jerry D. Stapella, Fort Lauderdale FL
Norman H. Starnes, Kingsport TN
Robert A. Steele, Mount Juliet TN
David L. Stegall, Levelland TX
Frank William Stout, Fayetteville NC
Steven William Suttle, Sonora CA
W. C. Swanson, St. Paul MN
Francis Earl Sweet, Shannon City IA
Edsel Lee Tackett, Shaw AFB SC
Donald R. Talbott, Bloomington IN
Anthony Taylor, Moss Point MS
Jay Evan Taylor, Elizabeth City NC
Timothy N. Taylor, Harrisonburg VA
William M. Taylor, Red Bluff CA
Walter Otto Teetzen, Sheboygan WI
Robert A. Thomas, Griffin GA
William G. Thompson, San Jose CA
Walter Edwin Thomson, Kenosha WI
Roger L. Tibbetts, Portage IN
Larry Tiner, Jacksonville FL
Robert Winston Tipps, Winchester TN
George R. Tips, San Antonio TX
Carl W. Tomlinson, Michigan City IN
Robert E. Travella, Spring Lake NC
Carl Lee Trent, Gaither MD
Selwyn R. Tuttle, Madison WI
Tim Allen Tyson, Savannah GA
Ronald Urban, New York
Khanh Van Tran, Albuquerque NM
David R. Van Wye, Mechanicsburg PA
Leonard Joseph Veraldi, Fort Meade MD
Alfred A. Villarreal, Jr., Falfurrias TX
Vladimirs Volnistijs, Ottawa ON Canada
Walter Burton Wair, Tacoma WA
Anthony L. Walters, FPO San Francisco
Geraldine S. Ward, APO New York
Thomas Wardlaw, Jr., East Kingston NH
David E. Weagly, Chambersburg PA
Daniel Eugene Wenberg, Berrien Springs MI
Duane E. Wenzel, River Grove IL
Randy E. Werner, St. Paul MN
James M. Whalen, Waterbury CT
Michael R. Whalen, Glen Burnie MD
Barry T. White, Pine City MN
Dennis J. Wieschowski, Alpena MI
John K. Williams, Jr., Saint Charles IA
Michael P. Williams, Fort Bragg NC
William H. Williams, Bolivia NC
David Winegardner, Kokomo IN
Donald J. Wittenauer, Port Orchard WA
Chris A. Wolf, Fort Wayne IN
Charles R. Wolfson, Reston VA
Roger Woodburn, Rockport IN
Morgan E. Woodhouse, Wht. Sulpher Spr. WV
J. W. Woody, Houston TX
Robert Lee Worsham, Huntington IN
Michael J. Worswick, Marine City MI
Richard William Worth, Kent WA
Reuben Zabel, Cathay ND

WITH HONORS

William F. Abbott, Ocean Springs MS
John Earl Adams, Morgan Hill CA
Ray Robinson Adams, Mount Dora FL
Earl Aitken, Chicago IL
Bruce L. Alexander, San Antonio TX
Fred M. Alexander, Southern Pines NC
Jay E. Allmon, Dickson TN
Russell Ames, Brethren MI
Gumersindo M. Aponte, Ponce PR
Ronald R. Ashworth, Minot ND
Timothy Ray Atwood, Yreka CA
Harry W. Aurand, Williamson NY
Gabriel Aviles R., Norfolk VA
James C. Baer, Bremerton WA
Frank A. Baker, Silver Peak NV
George Alan Baney, Bradbury Heights MD
Elwood G. Barr, Rantoul IL
David Bruce Bateman, Severn MD
James W. Bauer, Snyder NY
Ronald L. Beam, Carlyle PA
Edward Beardsley III, Wallingford CT

www.americanradiohistory.com

Gordon Beckett, Toronto ON Canada
Robert D. Beckham, Montgomery AL
John H. Beightol, La Grange WY
William R. Belcher, Somerville NJ
Brian Bellemare, Repentigny PQ Canada
Peter Bergeron, Poland Springs ME
Gordon Bethune, Braeside ON Canada
Thomas W. Binner, Wabasha MN
Armando Q. Binsol, Tamuning Guam
Harold M. Bird, Jr., East Leroy MI
William B. Bowie, Austin TX
Mark S. Bradley, Cuba NY
Edward P. Brady, Albany NY
Richard L. Brandes, Omaha NE
Gary W. Braumberger, Fairbanks AK
Clifford R. Breidenfeld, Lewistown MT
Dennis Lee Bristow, Portland OR
Bertram A. Brown, Mississauga ON Canada
Charles Brown, Jr., Bronx NY
Ronald D. Brown, Clay City KY
Frazer A. Budgell, Bishops Falls NF Canada
Gary M. Burch, Angola IN
Horace R. Burlison, Pascagoula MS
George W. Cage, Stanley NC
Richard A. Caggia, Valley Stream NY
Kenneth N. Campbell, Vestal NY
Michael S. Caracci, Rochester NY
Rick L. Carlile, Alva OK
Clarence Lee Carr, Denton TX
Gary K. Carrington, Bronx NY
James W. Carter, Ocean NJ
Donald Casillo, APO New York
James E. Caspers, Loda IL
William E. Caton, Hyattsville MD
Elizardo H. Celestino, Port Aux Basques NF
Steven W. Clemens, Santa Rosa CA
Richard H. Colvin, Jr., Alamogordo NM
James T. Conner III, Canton MS
Steve C. Consolino, Watervliet MI
Eric E. Cooper, Anchorage AK
Ralph Herris Cousins, Portland OR
Richard A. Conroy, FPO New York
Luther B. Coy, McDonough NY
Kenneth T. Cronin, West Des Moines IA
Richard A. Cross, Aurora CO
Juan L. Cuin, Rio Piedras PR
Gilbert B. Dalit, Davis CA
Lowell W. Dammann, Eagan MN
Bobby G. Daniels, Denison TX
Lloyd A. Davidson, Portland OR
Frank O. Davis, Jr., Wimberly TX
Roscoe Davis, Jr., Peoria IL
Daniel N. Deitz, Mount Lookout WV
William Deleys, Webster NY
Kenneth Lee Deweese, Suffolk VA
Owen D. Dinger, Kaysville UT
Michael George Dirgo, Sharon PA
Clifton Dobbs, Vincent AL
John Doerler, Washington Crossing PA
Apolonio M. Dominguez, Fort Stockton TX
Thomas J. Donchez, APO New York
Arthur F. Druke, Oshkosh WI
Claude L. Du Bois, Manitouwadge ON Canada
H. Belden Dunn, Rockville MD
Clements N. Duval, Sterling Heights MI
John Brent Elliott, Bloomington IN
Jimmie D. Ellis, Houston TX
Shannon Ralph Eng, Everett WA
Joseph G. England, Fultondale AL
Frank J. Esposito, Baldwin NY
Bernard C. Eutsler, Los Alamos NM
Larry Boyd Evans, Sutherland VA
Tracy W. Evans, Middletown RI
H. B. Everette, Westville FL
Warren Lee Fackler, Los Angeles CA
Garlan V. Felix, Baltimore MD
Paul D. Fennern, Moorhead MN
David R. Fields, Cumberland KY
John R. Fowler, New Brighton PA
Joseph Paul Fragola, Smithtown NY
Ned B. Francisco, Bayard NM
Douglas T. Frederick, FPO San Francisco
Thomas J. Frederick, Derry PA
Horace Freeman, Trenton NJ
Leon E. Freeman, Bloomingdale MI
Gerald David Fuller, Saint Paul MN
David Leon Geary, Colorado Springs CO
William P. Geis, Jonesboro AR
Nicholas George, Anchorage AK
Edward J. Gerstkamp, Dubuque IA
John Van Ormer Gheer, Piscataway NJ
Norman L. Gilbert, Canton OH
David A. Gilley, Fall Branch TN
John W. Gilmore, Washington CH, OH
Anthony Giuliano, Spring Valley NY
Charles O. Given, Fort Myer VA
Delby A. Glass, Austin TX
William C. Gordon, Jr., Miami FL
Louis Gorski, La Porte IN
Huley H. Gray, Jr., Hillsboro MO
William Greenhalgh, Morrill NE
John W. Grimes, Deming NM
Robert S. Grimmett, Jr., Deville LA
Wayne G. Gross, Plainview NE
Robert Henry Gruber, Montgomery AL
David Habel, Hackettstown NJ
Willie Hall, Greenville SC
Alton Sidney Hanes, Dillwyn VA
Robert J. Hansen, St. James NY
Darrell Harrington, Copperas Cove TX
Floyd Harris, Great Lakes IL
Mellard G. Harrison, Tallahassee FL
Harland G. Harvey, Ilion NY
Daniel D. Hatheway, Troy NY
Joseph W. Hawkins, Chicago IL
Anthony Hayek, Kitchener ON Canada
Willie L. Haynes, Selfridge Angb MI
Emmett N. Head, Wahiawa HI
Thomas Sidney Helmer, Rockford OH
Darrell J. Hendrix, FPO New York
John D. Hensell, Cumberland MD
Charles L. Hertz, Oak Harbor WA
Dale A. Hewitt, Santa Ysabel CA
William G. Hindmarsh, Fremont NE
Franklin Henry Hobbs, Kingsville MO
Roland Hoffman, Edelstein IL
James W. Hofmann, Marshfield WI
Paul Dennis Holbert, Andrews AFB MD
Frank D. Holder, Jr., Mt. Home AFB ID
Joseph Lesley Holland, APO San Francisco
Everett S. Hopkins, Easton MD
Stephen Horvath, Whiting IN
Mike R. Hudran, Pueblo CO
John D. Iannicello, Windsor ON Canada
Youra Ilyinsky, Cleveland Heights OH
Harry R. Inabinet, Orangeburg SC
Guido Ingegneri, Bridgeton NJ
Thomas H. Irlbeck, Somerset WI
Richard Irwin, Fredonia NY
Harlan E. Jacobson, Kasson MN
Robert Edward Janson, Brewster MA
Joe M. Jenkins, Troy TX
Cecil A. John, Don Mills ON Canada
Edgar W. Johnson, Jr., Manchester Center VT
James C. Johnson, Enfield IL
Charles W. Jones, Hyattsville MD
Michael W. Jordan, Fort Hood TX
John Tetsuo Kai, Hubert NC
Steven James Kantner, State College PA
Hubert J. M. Kelkboom, Aruba Neth Antilles
Theodore Kelpinski, Buena Park CA
Hobert L. Kendrick, Dayton OH
William A. Kennison, Alexandria VA
Eddie L. Killgore, Charleston SC
Steven Bruce Kinzel, Dellwood MO
James G. Kirk, Malscott WV
Thomas A. Kluck, Owensboro KY
Peter Knorre, Rockland ON Canada
John F. Knowles, Seaford DE
Kenneth M. Korenek, Garwood TX
Larry Alan Kroon, San Diego CA
Lloyd L. Lacy, Lubbock TX
Allen H. Lambie, Kenosha WI
Dan Larabee, Cochrane ON Canada
Jerome H. Lawrence, Stuart FL
James M. Lee, Drumright OK
Paul M. Lee, Towanda IL
Robert G. Leget, Hauppauge NY
Joseph Lawrence Leitsch, Louisville KY
Chris E. Lindgren, Portland OR
Joseph Lipuscek, Teaneck NJ
Robert J. Livingston, Glendale AZ
Warren D. Loomis, Boise ID
Fred J. MacKenzie, Kingston ON Canada
Eugene J. Maier, Jackson MS
Stanley V. Maniecki, Coraopolis PA
Richard P. Manning, Lockport NY
Thomas H. Marsh, Clinton MI
Joseph J. Martin, Palisades Park NJ
Thomas E. Marts, Bremerton WA
Alfred E. Mazza, Clifford PA
L. W. McAmmond, Regina SK Canada
Ivan McCord, Vincennes IN
Robert F. McCulloch, Duncansville PA
John H. McCutchen, Littleton CO
Jerry McDowell, Royalton IL
John A. McHardy, Enterprise AL
James C. McNabb, Hendersonville NC
Rosalio Z. Menchaca, San Antonio TX
Carlos E. Mendoza, Edison NJ
Roland Preston Metcalf, Ayer MA
Arnold C. Middleton, FPO San Francisco
Robert A. Mierop Sr., Grahamsville NY
Joseph J. Mignogna, Jr., Severna Park MD
Charlie R. Miller, Fort Meade MD
Keith G. Milligan, Providence RI
James W. Miner, North Ridgeville OH
Gregory L. Mooney, Corpus Christi TX
Clarence Morris, El Paso TX
Robert K. Morrow, Jr., Garden Grove CA
Howard Moulson, Warren MA
George Randall Murphy, Royal Oaks MI
Richard A. Myrick, Old Hickory TN
David L. Nash, Kalamazoo MI
Johnnie H. Neal, Livingston TX
William G. Nedell, Chesapeake VA
N. W. Nelson, Cheyenne WY
Paul Nicholas, Bridgeport CT
M. M. O'Brien, Owasso OK
William Loyd Oddie, Ormond Beach FL
Rudolf Oey, Surrey BC Canada
Randy Allan Ognoskie, Needville TX
Gary A. Oliwa, Shelton CT
Thomas F. Olson, Glenview IL
James A. Orton, Salina KS
Gary Edward Palenchak, Jacksonville FL
Dennis F. Palestina, Chalmette LA
William N. Panning, Hubbard OH
Irineo I. Papa Sksa, FPO New York
Alberto C. Pascual, Elmhurst NY
Clifford L. Pearson, Pascagoula MS
Kenneth V. Pedersen, Crystal MN
John M. Peele, Brown Summit NC
Abel S. Perez, New Albany IN
Edward R. Perrine, Bricktown NJ
Norman W. Petersen, Port Hueneme CA
Walter L. Petersen, Solway MN
Burton L. Phillips, Jr., Summerville SC
Geoffrey E. Pierce, Newark DE
Tyrone D. Pinnix, Plattsburg AFB NY
Abdul S. Poona, Lancaster PA
Stephen Brent Pope, APO New York
Rodney A. Potolicchio, Virginia Beach VA
Richard Hanson Powell, Hinckley IL
Thomas E. Powell, Temple Hills MD
Robert K. Power, Merced CA
David F. Puthoff, Cincinnati OH
Michael Charles Rakaska, Charleston Heights SC
Robert Anthony Rapagna, Sterling VA
Dennis W. Rather, New Berlin WI
Charlie Rawlins, El Paso TX
Thomas H. Reichert, Pittsburgh PA
Walter A. Richards, Jr.,Wisconsin Rapids WI
Andrew H. Roben, Wantagh NY
Kenneth W. Roberts, Truro NS Canada
Lester Roberts, Holbrook NY
A. Nelson Rodgers, West Palm Beach FL
Robert Earl Rosbury, Riverview MI
John J. Roth, Essexville MI
Marshall B. Rothermel, Lillington NC
Larry Roy, Calgary AB Canada
Robert C. Ruddy, Cheshire CT
Ardell G. Ruether, Marthasville MO
David L. Ruff, La Crosse WI
Williebrudo Jose Ruiz, Groton CT
Robert A. Ruppel, Kings Park NY
Thomas Dwayne Rush, Sherman TX
George Rusnak, Jr., Fort Lauderdale FL
Kenneth R. Russell, North Little Rock AR

www.americanradiohistory.com

John Joseph Ryan, Miami FL
Donald F. Schliep, Grand Prairie TX
Richard Schultz, Andrews AFB MD
Mark A. Schutz, Miami FL
Wilburt B. Scott, Jr., Fort Bragg NC
Douglas D. Seuferer, FPO San Francisco CA
Pietro Sferra, Cincinnati OH
David J. Sherman, Bluffton OH
Raymond R. Sherry, Jr., New Tripoli PA
William D. Shevtchuk, Clifton NJ
Duane D. Sieler, Bismarck ND
Eugene L. Sielke, Richboro PA
Leslie R. Simpson, Fort Collins CO
Ernest T. Sisson, England AR
James Elwood Skaggs, Mars PA
John Kenneth Slocum, Oak Harbor WA
Edward Watson Smith, Fort Pierce FL
Michael J. Smith, Teeswater ON Canada
Sherman Duane Smith, Manhattan KS
Charles M. Snyder, Bakersfield CA
Robert W. Spencer, Baltimore MD
Michael W. Stagman, Townsend MT
William A. Steele, Lexington KY
Charles Richard Stees, Sr., Halifax PA
Gerald Robert Stees, Gautier MS
Bernhard Steinke, Belvidere IL
Harry H. Stimpson, Jr., Hallandale FL
John L. Stohel, Jr., Aberdeen MD
Jeffrey R. Stoll, Niagara Falls NY
Donald Lawrence Streit, Offerle KS
Charles M. Styer, Miami FL
Michael Dennis Swift, Fox Hollow Island KY
Thomas K. H. Swonger, Havelock NC
Ronald Lee Tatum, Central City KY
Homer Thomas Taylor, Austin TX
Raymond L. Thompson, Helena MT
Bill E. Thornhill, Nashville TN
Thomas R. Thrasher, Little Rock AR
John C. Threlkeld, Charleston SC
Kenneth C. Thurmond, Cuba MO
Frederick T. Traganza, Newtown Square PA
Gene Trusty, La Grange IL
Leroy E. Turner, El Paso TX
Alton F. Valley, Springfield MA
Ralph Vannick, Tofino BC Canada
Douglas W. Verhoff, Plattsburgh AFB NY
Vincent R. Villano, Uncasville CT
Salvatore L. Vitacco, Downers Grove IL
Ronald E. Wade, Cut-N-Shoot TX
Leemanuel A. Wakefield, Harvey IL
Vernon Leon Walker, Dahlonega GA
George E. Ward, Springfield OH
John D. Ward, Sr., Lansing MI
Allen E. Warren, Brimfield MA
John W. Watkins, APO New York
Ronald N. Watts, Bankston AL
Gary S. Webb, FPO New York
Thaddeus Wegrzyn, Downers Grove IL
Norman E. Wescott, Jr., Tilton NH
Percy S. West, St. Louis MO
Gary L. White, Odessa MO
Pressley McKim White, Marietta OH
Michael D. Wickham, Greely CO
Richard I. Willever, Lawrenceville NJ
David Williams, Medford WI
Frank P. Williams, Washington DC
Roy H. Williams, FPO San Francisco
Dale S. Withrow, Skagway AK
Marshall Wolfenbarger, Fort Lee VA
Norman Herbert Wong, San Francisco CA
Billy F. Wright, Lenoir City TN
Frederick R. Wunder, Oak Park IL
Charles William Yadon, Marquette MI
Philip L. York, Joplin MO
John R. Zook, Imperial PA

Don't Quit School.

When you join the NRI Alumni Association,
you receive a subscription to the NRI Journal,
unlimited free consultation service,
and an attractive membership card and pin.
More important,
you maintain your ties with your school,
the leading technical training school
in the United States.
Only four dollars a year, seven dollars for two years.

Your Alumni Association. It's For You.

www.americanradiohistory.com

Alumni News

Harry Taylor

SAN ANTONIO CHAPTER

Our most recent meeting centered around troubleshooting a black-and-white TV set. It was a small-screen Zenith tube-type with an agc/tuner problem. The defect turned out to be a short circuit in the agc amplifier tube socket.

We looked at a vintage (18 years old) Hughs tube-type dual-trace oscilloscope. We checked it for operation and analyzed the circuit. We determined that there was a defective part in the high-voltage section. We could not fix the scope as we did not have a correct replacement for the bad part.

David Bonnet has joined our Chapter. We are pleased to have him as a new member.

PITTSBURGH CHAPTER

We were privileged to have representatives from the TV industry speak at two of our recent meetings. Tom Buetscher, Service Manager of the J. A. Williams Company, gave us a firsthand look at the new line of Zenith color TV sets. He went over the circuitry and physical construction of these sets. The members were interested to see that these sets use no metal chassis. Instead, the circuits are on panels that are interconnected by cables. Surprisingly, the HV, horizontal output, and tuners are all on panels. The interconnections are so carefully engineered that the panels cannot be connected incorrectly.

Tom explained that this new construction is used in both the 19-inch and

www.americanradiohistory.com

25-inch Zenith sets and that the panels can be exchanged in case of failure. The service technician has the option of repairing defective panels or exchanging them for new or rebuilt panels.

Bill StClair, an instructor in servicing for General Electric, gave a talk on the 1979 General Electric color TV sets. He distributed service literature and showed the changes that we should look for when we begin servicing these new sets. He used a new video cassette recorder for his presentation. The members were nearly as interested in the VCR as they were in his presentation.

We thank both of these gentlemen for helping us stay abreast of the TV industry. We look forward to similar programs in the future.

FLINT/SAGINAW VALLEY

The Flint/Saginaw Valley chapter has met every two weeks throughout the summer, except for the month of August. Most of us took vacations during August. One of our members, Andy Jobbagy, went to Hungary to visit his "home country."

Our meetings since the spring have been a mixture of service training sessions and discussions of test equipment and home electronic equipment. We have worked on numerous TV sets, black-and-white and color, tube-type and solid-state, current models and vintage TV sets. We have also worked on test equipment, including a Conar oscilloscope, automobile radios, and home intercoms.

We worked on an Airline black-and-white TV that had sound but no raster. We began our troubleshooting in the high-voltage section. After checking and replacing suspected parts, we found that the cause of the problem was a shorted audio amplifier tube. We put in a new tube and the set played perfectly. We

DIRECTORY OF ALUMNI CHAPTERS

DETROIT CHAPTER meets at 8 p.m. on the second Friday of each month at St. Andrews Hall, 431 E. Congress Street, Detroit. Chairman: James Kelley, 1140 Livernois, Detroit, Michigan. 841-4972.

FLINT (SAGINAW VALLEY) CHAPTER meets 7:30 p.m. the second Wednesday of each month at Andy's Radio and TV Shop, G-5507 S. Saginaw Road, Flint. Chairman: Dale Keys. Phone (313) 639-6688. Shop phone (313) 694-6773.

NEW YORK CITY CHAPTER meets at 8:30 p.m. the first Thursday of each month at 1669 45th Street, Brooklyn, N.Y. Chairman: Sam Antman, 1669 45th Street, Brooklyn, New York.

NORTH JERSEY CHAPTER meets at 8 p.m. on the second Friday of each month at the Players Club, located on Washington Square in Kearny, New Jersey. Chairman: Al Mould. Telephone 991-9299 or 438-5911.

PHILADELPHIA-CAMDEN CHAPTER meets on the fourth Monday of each month at 8 p.m. at the home of Chairman Boyd A. Bingaman, 426 Crotzer Avenue, Folcroft, Pa. Telephone 583-7165.

PITTSBURGH CHAPTER meets at 8 p.m. on the first Thursday of each month in the basement of the U.P. Church of Verona, Pa., corner of South Avenue and Second Street. Chairman: George McElwain, 100 Glenfield Dr., Pittsburgh, Pa. 15235.

SAN ANTONIO (ALAMO) CHAPTER meets at 7 p.m. on the fourth Thursday of each month at the Alamo Heights Christian Church Scout House, 350 Primrose St., 6500 block of N. New Braunfels St. (three blocks north of Austin Hwy.), San Antonio. Chairman: Robert Bonge, 222 Amador Lane, San Antonio. All San Antonio area NRI students are always welcome. A free annual chapter membership will be given to all NRI graduates attending within three months of their graduation.

SOUTHEASTERN MASSACHUSETTS CHAPTER meets at 8 p.m. on the last Wednesday of each month at the home of Chairman Daniel DeJesus, 12 Brookview Street, Fairhaven, Mass. 02719.

SPRINGFIELD (MASS.) CHAPTER meets at 7:30 p.m. on the second Saturday of each month at the shop of Norman Charest, 74 Redfern Drive, Springfield, Mass. 01109. Telephone (413) 734-2609.

TORONTO CHAPTER meets at McGraw-Hill CEC, 330 Progress Ave., Scarborough, Ontario. For information contact Stewart J. Kenmuir, (416) 293-1911.

www.americanradiohistory.com

found that the tube plate was connected to the horizontal output transformer. The short in the tube increased the current through the transformer winding so that the high-voltage section could not develop the usual high voltage.

Dennis Besser brought in a Philco color TV that had a good picture but no sound. The trouble turned out to be a bad audio output transistor. We located the trouble by injecting a signal at the volume control. We confirmed the defect with an ohmmeter and a transistor checker.

Jeff Cyphert had a little trouble with the Conar oscilloscope which he put together. Jerry Lev, who had assembled an oscilloscope previously, helped him trace the circuit and locate the problem. It turned out to be a fairly common wiring error. It is always helpful to have someone else look over your wiring, when possible.

In addition to sharpening our skills as service technicians, we managed to do some good for mankind in our Alumni meetings. We repaired several TV sets and gave them to charity. Some of the sets were completely inoperative when we received them so we gained experience in working on them before we passed them on.

We were pleased to welcome Thomas D. Sharp to our Alumni chapter. Tom is a student of the NRI Complete Communications Electronics course and he intends to become a CB service technician after completing his course.

NORTH JERSEY CHAPTER

Mr. Oswald (Tex) Judisch led a discussion on two-meter (144-148 MHz) ham radio. Tex, WB2HDV, is a retired ship radioman and a very active ham. He explained how the two-meter rig works and how repeaters are used in two-meter communications. Two-meter portables are low-powered and have limited range. Repeaters, therefore, greatly extend the range of reliable communications.

In a future meeting, we will have a slide presentation from GTE Sylvania on color picture tubes. We will also have meetings on the operation and use of electronic test equipment, including the new digital multimeters.

SPRINGFIELD (MA) CHAPTER

The last meeting was held at the home of Norman Charest, chairman of the Springfield Chapter. The Chapter joined forces in solving the problems in three color TV sets.

We worked on a Sylvania portable color set with vertical bars in the picture. We found the trouble in the screen grid circuit of the horizontal output amplifier stage. There was insufficient decoupling.

Next, we tackled a GE 19-inch color set with an hourglass-shaped picture. This pattern was caused by a defective deflection yoke. The vertical signal was getting into the horizontal deflection current waveform. Replacing the deflection yoke cleared up the trouble.

After solving the problem in the GE set, we turned our attention to a Zenith 25-inch color TV. This set had two black bars on each side of the picture. We traced the trouble to the screen grid circuit of the picture tube. We replaced a defective 820-ohm resistor and a 0.01-μF decoupling capacitor and the set worked perfectly.

Finally, we worked on a Bradford Model 1171B22 set with a high-voltage problem. We did not locate the trouble and decided to save it for a future meeting.

We postponed our annual picnic until we decide where to hold it this fall.

www.americanradiohistory.com

NEW YORK CITY CHAPTER

The chapter covered a variety of subjects at our most recent meeting. Chairman Sam Antman reported a funny, but common TV problem: operator error. Sam was asked to check out a remote control unit for a Sony TV. The remote unit worked fine but it would not control the TV set. It seems that there is a switch on the front of the TV set to disable the remote control. The customer's five-year-old grandchild found the switch and switched it off. The customer did without the remote control for several weeks before he finally decided to "get it fixed." The "fix" was to turn the switch back on. This customer, like many others, probably lost the instruction booklet before he got around to reading it.

Robert White reported that he had solved the problem of an overheating damper tube in a TV set which he had spoken about previously. The trouble was a shorted 570-ohm resistor in the damper circuit.

Previously, Pete Carter had brought to our attention an intermittent power supply problem in an Emerson TV. He reported that the defect was a bad electrolytic capacitor in the bridge rectifier circuit.

Before we adjourned, we brought out our Conar Model 600 color TV and went through the color setup procedure: convergence and gray scale and purity adjustments. The meeting ended with refreshments.

Job Ops

ENGINEER/ANNOUNCER: Urgently needed for WWOD Radio, 2020 Mimosa Road, Lynchburg, Virginia 24503. Must have First-Class FCC Radiotelephone. Telephone collect (804) 384-1211.

HELP WANTED: Small-appliance repairman to operate own business in appliance store and earn commissions on TV and appliance sales. Contact Mutual TV and Appliance Center, 754 Main Street, Amherst, Massachusetts 01002.

TECHNICIANS WANTED: Growing automotive radio sales, service, and installation center needs technicians familiar with analog and digital electronics. First-Class or Second-Class FCC license helpful but not necessary. Contact Michael Montgomery, F&M Stereo Center, 5809 Jensen Drive, Loves Park, Illinois 61111.

CB TECHNICIAN WANTED: To repair and service CB transceivers. Experience or training in servicing preferred. Full-time permanent position. Contact Bob Jeffrey, Glen Ellyn CB Hut, 805 North Main Street, Glen Ellyn, Illinois 60137. Telephone (312) 469-5715.

OPERATOR/TECHNICIANS WANTED: For WXCL and WZRO-FM Stereo in Peoria, Illinois. Must have FCC First-Class Radiotelephone. Light programming of FM with DEC computer. Knowledge of transmitter remote control and calibration, ability to build small electronic projects in well-equipped shop, ability to solder very neatly. Knowledge of phasors, base currents, phase monitors, field intensity meters, and monitoring points is a plus. Contact Melvin Feldman, 3641 Meadowbrook Road, Peoria, Illinois 61604. Telephone (309) 685-5975.

SERVICE TECHNICIANS NEEDED: Growing TV/audio servicing business urgently needs service technicians. NRI students and graduates preferred, full- or part-time. Contact Roger Jones, Christian TV and Audio, 6916 Silverstar Road, Orlando, Florida 32808. Telephone (305) 293-7288.

www.americanradiohistory.com

CONAR

A Division of the National Radio Institute
3939 Wisconsin Avenue
Washington, D.C. 20016

CHECK ONE:
- ☐ Cash order
- ☐ COD (20% deposit required)
- ☐ Select-A-Plan order

CHECK ONE:
- ☐ New Conar account
- ☐ Add-on Conar account
- ☐ Reopen Conar account

PLEASE PRINT

____
NRI Student or Graduate No.

Name ______________________

Address ______________________

City ____________ State ______ Zip code ______

Social Security No. ______________________

Ship to another address? Give directions here:

Name ______________________

Address ______________________

City ____________ State ______ Zip Code ______

c/o ______________________

Moved since last order?

Previous address ______________ City ____________ State ______ Zip code ______

1. Name of Item	2. Stock No.	3. How Many?	4. Price Each	5. Total	Wt.

IMPORTANT:

To speed handling, any correspondence should be on separate paper.

All prices are net FOB, Washington, D.C.

Please include postage for weight shown and insurance on Parcel Post orders.

A 20% deposit is required on COD orders. Select-A-Plan orders: Please complete reverse side and sign payment agreement below. Thank you for your order.

6. Total cash price for merchandise		
7. Parcel Post and insurance		
8. 10% cash down payment and Parcel Post costs required on new Conar accounts.		
9. Unpaid balance of cash price (Items 6 and 7 less item 8)		
10. Sales tax (Washington, D.C. residents only)		
11. Unpaid balance (Amount to be financed) (Item 9 plus item 10)		

Prices in the Conar catalog and Select-A-Plan time payment privileges apply only to residents of the United States and Canada. Residents of Canada and foreign countries are responsible for customs charges.

PAYMENT AGREEMENT

Enclosed is a down payment of $ ______ on the merchandise I have listed on the Conar Order Form. I will pay Conar a minimum payment of 7% of the beginning unpaid balance or $5 per month, whichever is greater, until the full balance plus applicable interest is paid. Title to and right of possession of the merchandise shall remain in Conar Instruments until all payments have been made. If I do not make the payments as agreed, Conar may declare the entire balance immediately due and payable. In satisfaction of the balance, Conar may, at its option, take back the merchandise, which I agree to return upon request. I agree that the above conditions shall apply to any add-on purchases to my account. The statements on my credit application are true and are made for the purpose of receiving credit.

Date ______________ Buyer sign here ______________________

Please do not write in this space.

www.americanradiohistory.com

RETAIL INSTALLMENT CONTRACT AND SECURITY AGREEMENT

CONAR SELECT-A-PLAN

SELECT YOUR TERMS TO FIT YOUR BUDGET

CONAR FINANCIAL RATES

The Finance Charge on balances up to $500 is 1½% per month. On any portion of a balance over $500, the rate is 1% per month. This is an Annual Rate of 18% and 12% respectively. The Finance Charge is computed on the month end balance of your billing cycle. You will receive a statement each month approximately 10 days before your payment is due. It will give you the current balance, finance charge, list payments made during billing cycle, date your payment is due, and amount of minimum payment due.

HOW TO DETERMINE THE AMOUNT OF YOUR MONTHLY PAYMENT

The minimum monthly payment on a Conar account is 7% of the original unpaid balance or $5, whichever is greater. The 7% is calculated to the nearest dollar. For example, if your original balance is $140, your payment would be $10. If your original balance is $160, your payment would be $11.

And remember—every purchase carries the Conar Guarantee—"the best in the industry."

TO SPEED SHIPMENT

1. Complete other side of this sheet.
2. Insert amount of down payment (at least 10% of total order) and other information in Payment Agreement on other side.
3. Sign Payment Agreement and fill in Credit Application.

IMPORTANT: Additional purchases—Once your credit is established and you have made at least three payments on your account, you can "add on" to your account with purchases of $20 or more. No down payment is required for add-ons of less than $100. If you are under 21, please have the Payment Agreement and credit application filled out and signed by a person over 21. He can make the purchase for you and will be responsible for payment. If you have a Conar account open or recently paid in full, just sign the Payment Agreement.

NOTICE TO THE BUYER: (1) Do not sign this agreement before you read it or if it contains any blank space. (2) You are entitled to a copy of this agreement.

IT'S AS EASY AS A - B - C TO OPEN A CONAR ACCOUNT

PLEASE ALLOW ADEQUATE TIME FOR NORMAL ROUTINE CREDIT CHECK. ONCE YOUR CREDIT IS ESTABLISHED, ONLY YOUR SIGNATURE IS NEEDED TO ADD ON PURCHASES.

WHERE DO YOU LIVE?

A ➔

Print full name ____________________ Age ______

Home address ____________ City ________ State ____ Zip code ______

Home Phone ________ How long at this address? ________ ( ) Own home ( ) Rent

Rent or mortgage payments $ ____ per month ( ) Married ( ) Single Wife's name ______

No. dependent children ____ Previous address ____________ How long? ______

WHERE DO YOU WORK?

B ➔

Your employer ____________________ Monthly income $ ______

Employer's address ____________________

How many years on present job? ________ Position ____________

Previous employer ____________________

Wife's employer ____________________ Monthly income $ ______

WHERE DO YOU TRADE?

C ➔

Bank account with ____________________ ( ) Checking ( ) Savings ( ) Loan

Address ____________________

Credit account with ____________ Address ____________

Credit account with ____________ Address ____________

Total of all monthly payments including car $ ______

CONFIDENTIAL

www.americanradiohistory.com

Instruments for the Eighties.

New from CONAR.

Model 281 Signal Generator

Stock No. 281UK

Now, from CONAR, an indispensable instrument for every electronics technician—with all-new solid-state circuits and **DIGITAL READOUT!**

Student Price

Only $89.50

Plus shipping and insurance
(Check the CONAR catalog for Parcel Post and UPS rates)

KITS ONLY
until early 1979

Specifications

Accuracy: Better than 1 percent of displayed frequency. **Attenuator**: Continuously variable control provides a minimum attenuation of 40 dB at 30 MHz and below. **Modulating Frequency**: Low-distortion 1000-Hz sine wave. **AM Modulation**: Adjustable at the front panel from 0 percent to 50 percent or better. **FM Modulation**: True fm using a dual varactor modulator. **Maximum Deviation**: 0 to 40 kHz at 4.5 MHz, 0 to 80 kHz at 10.7 MHz, and 0 to 200 kHz at 21.4 MHz. **Output**: Unmodulated rf, amplitude-modulated rf, frequency-modulated rf, and 1000-Hz audio. **Output Amplitude**: 0 dBm (200,000 microvolts), 3 dB into 50 ohms, 180 kHz through 30 MHz. Second harmonic of any selected frequency between 180 kHz and 30 MHz is 20 dB below the fundamental output or better. **Amplitude Variation**: Over any single band is 6 dB maximum. Audio output (1000 Hz) is 8 volts peak-to-peak or better into 1 megohm. **RF and Modulated RF**: Continuously variable within five bands. Band A: 175 kHz to 545 kHz. Band B: 540 kHz to 1.610 MHz. Band C: 1.600 MHz to 4.310 MHz. Band D: 4.300 MHz to 13.510 MHz. Band E: 13.500 MHz to 30.500 MHz. **Semiconductors**: Five integrated circuits, four transistors, two dual-gate MOSFETs, two varactor diodes, four silicon diodes, five seven-segment LED displays. **Power Supply**: Transformer operated at 5 and 15 volts dc with integrated-circuit voltage regulation. **Cabinet Size**: 5½" high by 8½" wide by 6¼" deep. **Weight**: 4 pounds (net weight).

www.americanradiohistory.com

Instruments for the Eighties.

Model 312 Resistance/Capacitance Decade

Stock No. 312UK

From CONAR . . . another superb instrument for the electronics technician, with all-new solid-state circuitry and **DIGITAL READOUT!** Don't delay—order today from CONAR.

Only $53^{50}

Plus shipping and insurance
(Check the CONAR catalog for Parcel Post and UPS rates)

KITS ONLY
until early 1979

Specifications

Capacitance Ranges: 10 pF to 100 pF, 100 pF to 0.001 μF, 0.001 μF to 0.01 μF, 0.01 μF to 0.1 μF, 0.1 μF to 1 μF. **Resistance Ranges:** 10 ohms to 100 ohms, 100 ohms to 1 kilohm, 1 kilohm to 10 kilohms, 10 kilohms to 100 kilohms, 100 kilohms to 1 megohm, 1 megohm to 10 megohms. **Capacitance Null Accuracy:** Better than 5 percent ±5 pF. **Resistance Null Accuracy:** Better than 5 percent. **Maximum Null Width:** Within 3 percent of dial setting. **Bridge Supply Power:** 12.5 volts ac, 60 Hz. **Power Requirement:** 110-120 volts ac, 60 Hz. **Dimensions:** 8½" wide by 6" high by 6½" deep. **Shipping Weight:** 6 pounds.

NRI JOURNAL
3939 Wisconsin Avenue
Washington, D.C. 20016

MR WILLARD F VELLINE 25923 G
1322 S 14 1-2 ST
FARGO ND 58102

Second-Class
Postage Paid
at Washington, D.C.
and Additional Entry

www.americanradiohistory.com